TRANSCRIPT OF RECORD.

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1896.

No. ~~402~~. 99.

BOYDEN POWER BRAKE COMPANY ET AL., APPELLANTS,

vs.

GEORGE WESTINGHOUSE, JR., AND THE WESTINGHOUSE AIR BRAKE COMPANY.

No. 116.

GEORGE WESTINGHOUSE, JR., AND THE WESTINGHOUSE AIR BRAKE COMPANY, APPELLANTS,

vs.

BOYDEN POWER BRAKE COMPANY ET AL.

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE FOURTH CIRCUIT.

FILED FEBRUARY 20, 1896.

(16,137 & 16,168.)

(16,137 & 16,168.)

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1896.

No. 403.

BOYDEN POWER BRAKE COMPANY ET AL., APPELLANTS,

vs.

GEORGE WESTINGHOUSE, JR., AND THE WESTINGHOUSE AIR BRAKE COMPANY.

No. 426.

GEORGE WESTINGHOUSE, JR., AND THE WESTINGHOUSE AIR BRAKE COMPANY, APPELLANTS,

vs.

BOYDEN POWER BRAKE COMPANY ET AL.

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE FOURTH CIRCUIT.

INDEX.

JUDD & DETWEILER, PRINTERS, WASHINGTON, D. C., JUNE 5, 1896.

BLEED.

BLEED. THR

a United States Circuit Court of Appeals, Fourth Circuit.

Boyden Power Brake Company; George A. Boyden, President; Charles B. Mann, Secretary; William Whitridge, Treasurer, and Boyden Brake Company, Appellants, *versus* George Westinghouse, Jr., and The Westinghouse Air Brake Company, Appellees.	No. —.

Appeal from the circuit court of the United States for the district of Maryland.

b United States of America, District of Maryland, } *To wit:*

At a circuit court of the United States for the fourth circuit, in and for the district of Maryland, begun and held at the court-house in the city of Baltimore, on the first Monday of April, being the first day of the same month, in the year of our Lord one thousand eight hundred and ninety-five—

Present: The Honorable Thomas J. Morris, judge of the Maryland district; William L. Marbury, Esq., attorney; Charles H. Evans, Esq., marshal; James W. Chew, clerk—

Among other were the following proceedings, to wit:

George Westinghouse, Jr., and The Westinghouse Air Brake Company *vs.* Boyden Power Brake Company; George A. Boyden, President; Charles B. Mann, Secretary; William Whitridge, Treasurer, and Boyden Brake Company.	In Equity.

1 *Bill of Complaint.*

Filed December 12, 1889.

Circuit Court of the United States in and for the District of Maryland. No. — of —— Term, 188–.

George Westinghouse, Jr., and The Westinghouse Air Brake Company *versus* Boyden Power Brake Company; Charles A. Boyden, President; Charles B. Mann, Secretary, and William Whitridge, Treasurer.	In Equity.

To the honorable the judges of the circuit court of the United States in and for the district of Maryland:

George Westinghouse, Jr., a resident of Pittsburg, Allegheny county, Pennsylvania, and the Westinghouse Air Brake Company, a corporation duly organized under the laws of the State of Penn-

sylvania, and doing business at Pittsburg aforesaid, and both being citizens of said State, bring this their bill of complaint against Boyden Power Brake Company, a corporation organized under the laws of the State of Maryland, and doing business at Baltimore, in said State; George A. Boyden, president of said corporation last named; Charles B. Mann, secretary thereof; and William Whitridge,
2 treasurer thereof—all residing in Baltimore aforesaid, and all being citizens of the State last named.

And thereupon your orators complain and say that George Westinghouse, Jr., one of your orators, was and is the true, original and first inventor of certain new and useful improvement in air valve for power brakes, not known or used before his invention thereof, and not, for more than two years prior to the date of his application for a patent therefor, in public use or on sale.

And your orators further show unto your honors that the said George Westinghouse, Jr., so being the inventor of said improvement, and being a citizen of the United States, made application to the proper department of the Government of the United States for letters patent, in accordance with the then existing laws of Congress, and having duly complied in all respects with the conditions and requisitions of said laws, on the fifth day of October, A. D. 1875, letters patent of the United States No. 168,359, signed, sealed and executed in due form of law, for his invention were issued and delivered to the aforesaid George Westinghouse, Jr., whereby there was secured to him and to his heirs, legal representatives and assigns, for the term of seventeen years from the fifth day of October, in the year A. D. 1875, the full and exclusive right of making, using and vending to others to be used, the said improvement.

And your orators further show that a description or specification of the aforesaid improvement was given in the schedule to the aforesaid letters patent annexed, accompanied by certain drawings referred to in said last-mentioned schedule, and forming part of said letters patent. The said letters patent, and the said specification thereto annexed (which, or an exemplified copy of which, your orators will produce as your honors may direct), were duly recorded in the Patent Office.

And thereupon your orators further complain and say that the said George Westinghouse, Jr., was and is the true, original
3 and first inventor of certain new and useful improvement in fluid-pressure automatic brake mechanism, not known or used before his invention thereof, and not, for more than two years prior to the date of his application for a patent therefor, in public use or on sale.

And your orators further show unto your honors that the said George Westinghouse, Jr., so being the inventor of said improvement, and being a citizen of the United States, made application to the proper department of the Government of the United States for letters patent, in accordance with the then existing laws of Congress, and having duly complied in all respects with the conditions and requisitions of said laws, on the 29th day of March, A. D. 1887, letters patent of the United States No. 360,070, signed, sealed and

executed in due form of law, for his invention, were issued and delivered to the aforesaid George Westinghouse, Jr., whereby there was secured to him and to his heirs, legal representatives and assigns, for the term of seventeen years from the 29th day of March, in the year A. D. 1887, the full and exclusive right of making, using, and vending to others to be used, the said improvement.

And your orators further show that a description or specification of the aforesaid improvement was given in the schedule to the aforesaid letters patent annexed, accompanied by certain drawings referred to in said last-mentioned schedule, and forming part of said letters patent. The said letters patent, and the said specification thereto annexed (which, or an exemplified copy of which, your orators will produce as your honors may direct), were duly recorded in the Patent Office.

And your orators further show unto your honors that prior to the commission of the acts of infringement hereinafter charged, by virtue of said patents and a certain instrument in writing, duly executed and recorded in the U. S. Patent Office, the said recited patents, and the entire right, title and interest therein and thereunder, became and still is duly vested in your orators, as by
4 said patents and instrument in writing, or duly certified copies thereof, ready in court to be produced, will fully and at large appear.

And your orators further show unto your honors that the said patented inventions are so nearly allied in character as to be capable of conjoint as well as separate use in the construction and operation of railway fluid-pressure brake mechanism, and have been so used by the defendants herein.

And your orators further show that they, your orators, have extensively applied the said several improvements to practical use, and have been, and but for the infringement hereinafter complained of, to wit, of claim 7 of patent No. 168,359, and claims 1, 2, 4 and 5 of patent No. 360,070, your orators would still be in the undisturbed possession, use and enjoyment of the exclusive privileges secured by the said letters patent and in the receipt of the profits of the same.

And your orators further show unto your honors, as they are informed and believe, that the said defendants herein named, well knowing all the facts hereinbefore set forth, are now constructing, selling and using railway fluid-pressure brake apparatus in material parts thereof substantially the same in construction and operation as in the said several letters patent mentioned, the exclusive right and privilege to make and use which, and vend the same to others to be used, is thus by law vested in your orators.

And so it is, may it please your honors, that the said defendants, as your orators are informed and believe, without the license of your orators, against their will and in violation of their rights have made, sold and used, and intend to continue still to make, sell and use the said improvements within the — district of Maryland and elsewhere in the United States, and refuse to pay to your orators any of the profits which they have made by such unlawful manu-

facture and use, or to desist from the further infringement of s recited letters patent, all of which acts and doings are in violat of the exclusive rights and privileges so as aforesaid vested in yo orators under and by virtue of said recited letters patent N
5 168,359 and 360,070, and are contrary to equity and go conscience, and tend to the manifest injury of your orat in the premises.

To the end, therefore, that the defendants may, if they can, sh reason why your orators should not have the relief hereby pray and that they may make a full disclosure and discovery of all t matters aforesaid, and upon their corporal oaths and under corp rate seal, and according to the best and utmost of their knowled remembrance, information and belief, full, true, direct and perf answer make to the matters and things hereinbefore stated a charged.

And that the said defendants may answer the premises, and th they may be decreed to account for and pay over the income profits thus unlawfully derived, or which might have been deriv from the violation of the rights of your orators, as aforesaid, yo orators pray that your honors, upon entering of the decree in fav of your orators against said defendants for infringement, as abo prayed for, may also proceed to assess, or cause to be assessed, und your directions, as well the profits or income derived therefrom, be accounted for as aforesaid, as also, in addition thereto, the dam ages sustained by your orators by reason of such infringement, an that your honors may increase the actual damages so assessed to sum equal to three times the amount of such assessment, under th circumstances of the willful and unjust infringement committed b said defendants as hereinbefore set forth; and further, that the sai defendants may be restrained from any further violation of th rights of your orators as aforesaid, your orators pray that you honors may grant a writ of injunction issuing from and under th seal of this honorable court, or issued by one of your honors, pe petually enjoining or restraining the said defendants, their clerks attorneys, servants, agents and workmen, from any further construc tion, or sale, or use in any manner of said patented improvements or any part thereof, in violation of the rights of your orators a aforesaid. And your orators further pray that a provisiona
6 or preliminary injunction be issued, restraining the said de fendants from any further infringement of said recited let ters patent, pending this cause, and they pray for such other relie as the equity of the case may require and to your honors may seem meet.

May it please your honors to grant unto your orators not only a writ of injunction conformable to the prayer of this bill, but also a writ of subpœna of the United States of America, directed to the said Boyden Power Brake Company, George A. Boyden, Charles B. Mann and William Whitridge, commanding them, on a day certain therein to be named, to appear and answer unto this bill of com plaint, and to abide and perform such order and decree in the

BLEED

premises as to the court shall seem meet and may be required by the principles of equity and good conscience.

GEORGE H. CHRISTY,
Solicitor for Complainant.

UNITED STATES OF AMERICA, }
Western District of Pennsylvania, } *ss:*

Before me, the subscriber, duly authorized to administer oaths, personally came H. H. Westinghouse, general manager of The Westinghouse Air Brake Company, one of the complainants in the foregoing bill named, who, being duly sworn, deposes and says that, so far as the statements herein contained are within his own knowledge, they are true, and so far as they are derived from the information of others he verily believes them to be true. And he further says that he verily believes the said George Westinghouse, Jr., in said bill named, to be the original, true and first inventor of the new and useful improvements which are described in the letters patent Nos. 168,359 and 360,070 granted to George Westinghouse, Jr., and mentioned in the foregoing bill. And further, that
7 the said deponent verily believes that the title of the said complainants is as set forth in said bill.

H. H. WESTINGHOUSE.

Sworn and subscribed before me this tenth day of December, A. D. 1889.

H. H. WHITTLESEY,
Notary Public.

[NOTARY'S SEAL.]

Subpœna.

THE UNITED STATES OF AMERICA, }
District of Maryland, } *To wit:*

To Boyden Power Brake Company; Charles A. Boyden, president; Charles B. Mann, secretary; William Whitridge, treasurer, Greeting:

You are hereby commanded that all excuses and delays set aside you be and appear at the clerk's office of the circuit court [SEAL.] of the United States for the fourth circuit, in and for the district of Maryland, on the first Monday in January next, to answer unto the bill of complaint of George Westinghouse, Jr., and the Westinghouse Air Brake Company, in said court exhibited against you. Hereof you are not to fail at your peril, and have you then and there this writ.

Witness, the Honorable Melville W. Fuller, Chief Justice of our Supreme Court, the twelfth day of December, in the year of our Lord 1889.

Issued 12th day of December, 1889.

JAS. W. CHEW, *Clerk*.

7a MEMORANDUM.—The defendants are required to enter th appearance in the suit in the clerk's office on or before t first Monday of January next; otherwise the bill may be taken *p confesso.*

Marshal's Return.

"Summoned the Boyden Power Brake Company, by service Geo. A. Boyden, president. Summoned Geo. A. Boyden, Chas. Mann and Wm. Whitridge.

GEO. H. CAIRNES,
U. S. Marshal."

7b *Answer.*

Filed February 3, 1890.

In the Circuit Court of the United States for the District Maryland.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY
vs.
BOYDEN POWER BRAKE COMPANY; GEORGE A. BOYDEN, President; Charles B. Mann, Secretary; William Whitridge, Treasurer. } In Equity

To the honorable the judges of the circuit court of the United State in — for the district of Maryland:

The joint and several answer of the Boyden Power Brake Company of Baltimore City and of George A. Boyden, Charles B. Mann and William Whitridge to the bill of complaint of George Westinghouse, Jr., and the Westinghouse Air Brake Company against these defendants in this court exhibited.

These defendants now and at all times hereafter saving and reserving to themselves all manner of benefit and advantage of exception to the many errors, insufficiencies and inaccuracies
8 in the complainants' said bill of complaint contained, for answer thereto or unto so much and to such parts thereof as these defendants are advised that it is material to make answer unto, say:

1. They admit that the first-named defendant is a corporation created under the laws of the State of Maryland and doing business in the said State, and that the said Boyden, Mann and Whitridge are, respectively, the president, secretary and treasurer of the said company, and that they reside in the city of Baltimore and are citizens of the State of Maryland.

2. They admit that the said company is engaged in man-facturing and selling a fluid-pressure brake; but they deny that the said brake, or any part thereof, is an infringement on the letters patent issued to the complainants and described in said bill of complaint;

BLEED.

and they deny all the allegations contained in the said bill, except such as may be specifically admitted in this answer.

3. For further answer they deny, on information and belief, that the said George Westinghouse, Jr., was the true and original and first inventor of the apparatus covered by the letters patent mentioned in the said bill; and they further say, on information and belief, that the said apparatus was not an invention when produced by the said George Westinghouse, Jr., and that it was not novel, but that an apparatus substantially identical in character therewith was previously patented in letters patent of the United States granted to George Westinghouse, Jr., on March 5, 1872; and that like apparatus was previously described in the following letters patent of the United States:

No. 138,827 to George Westinghouse, Jr., May 13th, 1873.
No. 144,006 to George Westinghouse, Jr., October 28th, 1873.
9 No. 163,089 to Henry E. Marchand, May 11th, 1875.
No. 166,405 to H. Lansing Perine, August 3, 1875.
No. 168,359 to Geo. Westinghouse, Jr., October 5, 1875.
No. 172,064 to Geo. Westinghouse, Jr., January 11th, 1876.
No. 220,556 to Geo. Westinghouse, Jr., October 14th, 1879.
No. 280,285 to Geo. A. Boyden, June 26th, 1883.

4. And these defendants further answering, on information and belief, say that the said alleged invention was in public use more than two years before the said George Westinghouse, Jr., made any application for letters patent thereon, and that the said George Westinghouse, Jr., actually abandoned the said invention before any application was made.

5. And further answering so much of the said bill as alleged an infringement of the seventh claim of letters patent No. 168,359, they say that the said claim can only be construed as covering the specific construction named in the said claim, and that these defendants do not use the said construction; and that the construction used by these defendants cannot infringe the subject-matter of the said claim, for the reason that it is substantially found in several of the prior patents above cited.

6. And for answer to so much of the said bill as alleges an infringement of the first, fourth and fifth claims of letters patent No. 360,070, these defendants say that the valve used by them does not embody the combination of parts set forth in the said claims and does not infringe any patent included therein.

7. And in respect to the alleged infringement of the second claim in the said letters patent, these defendants say that the said second claim is invalid and should not have been granted, because
10 the combination of parts therein named is inoperative to perform and incapable of performing the function set forth in said claim; and that if the said claim be considered merely as the combination of parts therein set forth and without reference to the function described as performed by it, it is invalid for the reason that the same combination of parts is shown in most of the prior patents above cited, and has been publicly used by the com-

plainants for a long time prior to the date of the said letters patent No. 360,070.

8. And, further, these defendants say that the said second claim is uncertain and ambiguous, and that if the functions which are recited in the said claim should be so construed as amplifying the description of the elements or parts composing the combination as to distinguish this combination from that shown in most of the prior patents above cited, then the defendants say that the said claim is anticipated by the prior letters patent issued to George A. Boyden on June 26, 1883; for the reason that air-brake valves made in accordance with the last-mentioned patent embody the same combination of parts, and will perform the same functions and operate in substantially the same manner as stated in the said second claim.

Wherefore, these defendants humbly pray to be hence dismissed with their reasonable costs and charges in that behalf wrongfully sustained.

[SEAL OF COMP'Y.]

BOYDEN POWER BRAKE CO.,
By G. A. BOYDEN, *President.*
BARTON & WILMER,
COWEN & CROSS,
Solicitors for All the Respondents.

UNITED STATES OF AMERICA, *District of Maryland,* } *To wit:*

11 I, George Morris Bond, a commissioner of the United States of America in and for the district of Maryland, do hereby certify that on this 3d day of February, in the year eighteen hundred and ninety, personally appeared before me in my said district, George A. Boyden, and made oath that the matters and things stated in the foregoing answer as of his own knowledge are true, and that the matters and things therein stated as upon information and belief, are true to the best of his knowledge, information and belief.

[COM'R'S SEAL.]

GEORGE MORRIS BOND,
United States Commissioner for the District of Maryland.

G. A. BOYDEN, *President.*

Petition and Order Making the "Boyden Brake Company" Party Defendant.

Filed February 10, 1890.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY *vs.* BOYDEN POWER BRAKE COMPANY; GEORGE A. Boyden, President; Charles B. Mann, Secretary, and William Whitridge, Treasurer.	In the Circuit Court of the United States for the District of Maryland.

Petition of the Boyden Brake Company.

To the honorable the judges of the circuit court of the United States for the district of Maryland:

The petition of the Boyden Brake Company respectfully represents that since the filing of the bill in this cause, the said Boyden Power Brake Company assigned unto your petitioner all its
11*a* right, title and interest in the patents mentioned in said bill of complaint, and also all the property of the said Boyden Power Brake Company of every kind and description; all its property, choses in action and estate of every description whatsoever; and that it is the successor of the said Boyden Power Brake Company, and as such is engaged in the manufacture of the fluid pressure of the brake apparatus mentioned in said bill of complaint, and it prays this honorable court that it may be substituted as defendant in said cause, and have leave to answer the said bill of complaint.

And as in duty, etc.

COWEN & CROSS,
BARTON & WILMER, *Solicitors.*

Order.

On the foregoing petition, it is, this 10th day of February, 1890, ordered by the court that the said Boyden Brake Company be made party defendant in said cause, and that it have leave to answer therein.

THOS. J. MORRIS, *Judge.*

11*b* *Answer of the Boyden Brake Company of Baltimore City.*

Filed February 10, 1890.

WESTINGHOUSE *et als.* *vs.* BOYDEN *et als.*	In Circuit Court of United States, District of Maryland.

The answer of the Boyden Brake Company of Baltimore City to the bill of complaint in this case.

This defendant adopts the answer of its codefendants as fully as if more specifically replied to, and also the prayer therein contained.

[SEAL.] THE BOYDEN BRAKE COMPANY OF BALTIMORE CITY.

COWEN & CROSS,
BARTON & WILMER, *Solicitors.*

Before the subscriber, personally appeared Geo. A. Boyden, the president of the Boyden Brake Company, and made oath in due form of law that the matters and things set forth in the answer above described are true to the best of his knowledge and belief, this tenth day of February, 1890.

R. LYON ROGERS,
U. S. Commissioner for Maryland.

11*c* *Replication.*

Filed March 3, 1890.

United States Circuit Court, District of Maryland.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY *vs.* THE BOYDEN POWER BRAKE COMPANY; George A. Boyden, President; Charles B. Mann, Secretary, and William Whitridge, Treasurer.	No. 321. In Equity.

The replication of George Westinghouse, Jr., and The Westinghouse Air Brake Company, complainants, to the answer of The Boyden Power Brake Company; George A. Boyden, president; Charles B. Mann, secretary, and William Whitridge, treasurer, defendants.

These repliants, saving and reserving to themselves all and all manner of advantage of exception to the manifold insufficiencies of the said answer, for replication thereunto say, that they will aver and prove their said bill to be true, certain and sufficient in the law

to be answered unto; and that the said answer of the said defendants is uncertain, untrue and insufficient to be replied unto by these repliants; without this that any other matter or thing whatsoever in the said answer contained, material or effectual in the law to be replied unto, confessed and avoided, traversed or denied, and not herein replied unto, confessed and avoided, traversed or denied, is true; all which matters and things these repliants are and will be ready to aver and prove, as this honorable court shall direct; and they humbly pray, as *to* and by their said bill they have already prayed.

GEORGE H. CHRISTY,
Solicitor for Complainants.

Pittsburg, Pa., February 28, 1890.

11*d* *Amendment to Complainants' Original Bill of Complaint, by Consent.*

Filed March 3, 1890.

Circuit Court of the United States, District of Maryland.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY *vs.* BOYDEN POWER BRAKE COMPANY; CHARLES A. Boyden, President; Charles B. Mann, Secretary, and Wm. Whitridge, Treasurer.	No. 321. In Equity.

And now, to wit, 3d March, 1890, the complainants above named, by leave of court first had and obtained, amend their original bill of complaint by substituting "claim 7" for "claim 4" in the clause charging infringement of patent No. 168,359.

THOS. J. MORRIS, *Judge.*

Endorsed.

"We consent to the filing of the above amendment.

"BARTON & WILMER."

Appearance for Complainants.

Filed July 7, 1890.

GEORGE WESTINGHOUSE, JR., ETC., *vs.* BOYDEN POWER BRAKE COMPANY *et al.*	Circuit Court U. S. In Equity. No. 321.

Mr. Chew:

Enter my appearance as solicitor for complainants.

BERNARD CARTER.

ROUGH POOR COPY

12 *Appearance for Complainants.*

Filed November 21, 1893.

GEORGE WESTINGHOUSE, JR., *et al.* *vs.* BOYDEN POWER BRAKE COMPANY *et al.*	U. S. Circuit Court, District of Maryland.

PITTSBURGH, *November* 18, 1893.

James W. Chew, Esq., clerk U. S. circuit court, dist. Maryland, Baltimore, Md.

DEAR SIR: Please enter my appearance of counsel for complainants in above-entitled cause.

Very truly yours, J. SNOWDEN BELL.

13 United States Circuit Court, District of Maryland.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY *vs.* BOYDEN POWER BRAKE COMPANY; CHARLES A. Boyden, President; Charles B. Mann, Secretary, and William Whitridge, Treasurer.	In Equity. No. 321.

Depositions of witnesses and other evidence on behalf of complainants in above-entitled cause, under 67th rule in equity as amended, pursuant to notice and stipulation, before R. H. Whittlesey, special examiner, at the Hotel Albert, corner of Eleventh street and University place, in the city of New York, commencing at 10.30 o'clock a. m. on Tuesday, July 14th, 1891.

Present: J. Snowden Bell, Esq., of counsel for complainants, and Lysander Hill, Esq., of counsel for defendants.

It is stipulated and agreed that the defendant corporation has made, used, and sold, prior to the filing of the bill in this cause, and subsequent to the issue of the several letters patent sued on, and is now making, using and selling quick-action triple valves, of which Complainants' Exhibit Defendants' Quick-action Triple Valve is a specimen, and which are substantially shown and
14 described in plate XI of Complainants' Exhibit Defendants' 1891 Catalogue and the descriptive matter relating thereto.

Also, that Complainants' Exhibit Defendants' 1891 Catalogue is a catalogue issued and circulated by the defendant corporation.

Also, that printed Patent Office copies of United States letters patent and Blue Book copies of British letters patent, printed by the respective governments, may be referred to and offered in evidence by either party, without certification, with the same force and effect as if certified.

The several exhibits above specified are offered and put in evidence by counsel for complainants, and are marked as above stated.

It is further stipulated and agreed that the complainants' title is as set forth in the bill; copies of the instruments in writing making out the title to be offered in evidence prior to closing complainants' *prima facie* case.

It is further stipulated and agreed that the testimony of each party may be taken before any notary public not disqualified, and that complainants' testimony may be taken by R. H. Whittlesey, notary public, as special examiner, with the same force and effect as before a standing examiner of court or a special examiner duly appointed, and that an order to such effect may be entered, *nunc pro tunc*, at or before the hearing, and that a similar order may be entered, *nunc pro tunc*, with respect to the notary or notaries public to be selected by the defendants for the taking of their testimony.

It is also stipulated that all testimony shall be taken in longhand or in typewriting, without the aid of a stenographer.

Counsel for complainants offers and puts in evidence a printed Patent Office copy of letters patent No. 360,070, to George Westinghouse, Jr., for improvement in fluid-pressure automatic brake mechanism, dated March 29th, 1887, and the same is marked "Complainants' Exhibit Patent 360,070," R. H. Whittlesey, special examiner.

HENRY F. NEWBURY, a witness produced on behalf of complainants, being duly sworn, deposes and says, in answer to interrogatories proposed to him by J. Snowden Bell, Esq., of counsel for complainants, as follows, to wit:

Int. 1. State your name, age, residence and occupation.

A. Henry F. Newbury; age, 49; residence, 142 Park place, Brooklyn, N. Y.: am at present manager of the time-lock department of the Holmes Burglar Alarm Telegraph Company, whose office is 518 Broadway, New York city, and am a machinist by trade.

Int. 2. State the nature and extent of your mechanical experience and your experience in connection with questions relating to letters patent for inventions.

A. When a young man I learned the trade of a machinist, and have worked more or less at that trade until within a short time. While so engaged I became familiar with the use of tools and machinery and the working of metals, as well as the application of mechanical principles in the construction and operation of machinery of different kinds.

I also became familiar with the making and reading of mechanical drawings and have made many such drawings, as well as superintending the making of other drawings. While working at my trade I have had frequent occasion to design and construct, as well as superintend, the construction of various mechanisms relating to different manufactures.

For the past twelve years or more I have devoted a very large proportion of my time to the study of matters relating to patents and patented inventions, and while so engaged I have read the

specifications and drawings of large numbers of letters patent, both of the United States and foreign countries to learn wherein they resembled or differed from other mechanisms shown and
16 described in other patents or embodied in concrete form to enable me to point out such differences or resemblances.

I have very frequently for the past five years or more been called upon to testify as an expert witness in the United States courts, and, while so engaged, been called upon to point out resemblances and differences in patented mechanisms or structures therein in controversy, and I may say for this period of time almost my entire attention has been given to patents and patented structures.

Int. 3. Have you examined and do you understand letters patent No. 360,070, granted and issued to George Westinghouse, Jr., for improvement in fluid-pressure automatic brake mechanism, dated March 29th, 1887, "Complainants' Exhibit Patent 360,070"?

A. I have frequently read and carefully studied a printed Patent Office copy of the letters patent mentioned in the question, and I believe I understand the construction and operation of the mechanism therein shown, described and claimed.

Int. 4. Please describe briefly and generally the construction and operation of the mechanisms or devices described and shown in said letters patent, so far as the same may be necessary to a full understanding of the combinations of devices recited in the first, second and fourth claims thereof.

A. The specification of the said letters patent No. 360,070 refers to the object of the invention therein shown and described in the following language:

"The object of my invention is to enable the application of brake-shoes to car wheels by fluid pressure, to be effected with greater rapidity and effectiveness than heretofore, more particularly in trains of considerable length, as well as to economize compressed air in the operation of braking by utilizing in the brake-cylinders the greater portion of the volume of air which in former practice was directly discharged into the atmosphere.

"To this end my invention, generally stated, consists in a novel combination of a brake-pipe, an auxiliary reservoir, a brake-cylinder, and a 'triple-valve' device governing, primarily, communi-
17 cation between the reservoir and the brake-cylinder, and, secondarily, communication directly from the brake-pipe to the brake-cylinder."

The specification then goes on and describes in general terms the Westinghouse automatic brake as it had theretofore existed, and the difficulties encountered when applied to trains of considerable length, such as are used many times in what is known as freight service.

This description and reference is as follows:

"In the application of the Westinghouse automatic brake, as heretofore and as at present commonly in use, each car is provided with a main air pipe and auxiliary reservoir, a brake-cylinder, and a triple valve, the triple valve having three connections—to wit, one to the main air-brake pipe, one to the auxiliary reservoir, and

one to the brake-cylinder. The main air pipe has a stop-cock at or near each of its ends, to be opened or closed as required, and is fitted with flexible connection and couplings for connecting the pipes from car to car of a train, so as to form a continuous line for the transmission of compressed air from a main reservoir supplied by an air pump on the engine.

"When the brakes are off or released, but in readiness for action upon the wheels of the train, the air which fills the main reservoir and main air pipes has a pressure of from sixty-five to seventy-five pounds to the square inch, and by reason of the connections referred to, the same pressure is exerted in the casings of the triple valves on both sides of their pistons and in the auxiliary reservoirs connected therewith. At the same time passages called 'release ports' are opened from the brake-cylinders to the atmosphere. When it is desired to apply the brakes, air is allowed to escape from the main air pipe through the engineer's valve, thereby reducing the pressure in the main air pipe, whereupon the then higher pressure in the auxiliary reservoirs moves the pistons of the triple valves, so as to first close the passages from the triple valves to the brake-pipe, and at the same time close the release ports of all the brake-
18 cylinders, and then open the passages from the auxiliary reservoirs to the brake-cylinders, the pistons of which are forced out by the compressed air thereby admitted to the brake-cylinders, applying the brakes by means of suitable levers and connections, all of which mechanism is fully shown in various letters patent granted to me.

"The application of the brakes with their full force has heretofore required a discharge of air from the main pipe sufficient to reduce the pressure in said pipe below that remaining in the auxiliary reservoir after the brakes had been fully applied, and it has been found that, while the brakes are sufficiently quick in action on comparatively short trains, their action on long trains of from thirty to fifty cars, which are common in freight service under present practice, is in a measure slow, particularly by reason of the fact that all the air required to be discharged from the main pipe to set the brakes must travel from the rear of the train to a single discharge opening on the engine. This discharge of air at the engine has not only involved a serious loss of time in braking, but also a waste of air. Under my present invention a quicker and more efficient action of the brakes is obtained, and air which has been heretofore wasted in the application of the brakes is almost wholly utilized to act upon the brake-pistons."

The specification then goes on to state "That, in the practice of my invention, each railroad car, 1, on which it is applied is, as heretofore, provided with a main air pipe, 2, governed by stop-cocks, 3, adjacent to its ends, and having a flexible connection, 4, and coupling, 5, at each end, to admit of being coupled to the main air pipe of the tender, or the adjacent car or cars of a train. (See figure 1 for the arrangement of parts mentioned above, as well as those just following.) An auxiliary reservoir, 6, and brake-cylinder, 7, are secured in convenient position below the sills of the car, the

brake-cylinder having a piston, 52 (see Fig. 7), by the movement of which, through a system of lever connections, which do not form part of my present invention, the brake-shoes, 9, are applied
19 to and released from the wheels of the car, compressed air
being supplied to and released from the brake-cylinder, 7, as the pressure in the main air pipe is reduced or reinstated respectively, by means of a triple valve, 10, the casing or chest of which communicates with the main air pipe, the auxiliary reservoir, and the brake-cylinder.

"So far as the performance of its preliminary function in ordinary braking is concerned, that is to say, effecting the closure of communication between the main air pipe and the auxiliary reservoir, and the opening of communication between the auxiliary reservoir and the brake-cylinder in applying the brakes, and the reverse operations in releasing the brakes, the triple valve, 10, accords substantially with that set forth in letters patent of the United States No. 220,556, granted and issued to me October 14, 1879, and is not, therefore, saving as to the structural features by which it performs the further function of effecting the direct admission of air from the main air pipe to the brake-cylinder, as presently to be described, claimed as of my present invention. Certain of its elements devised and employed by me prior thereto will, however, be herein specified, in order to render its construction and operative relation to other members of the brake mechanism fully intelligible."

Briefly stated, a triple valve, in general, contains a piston chamber in which a piston works, which chamber is open to, or in commu-

(At this point of the examination the expert states that he desires to make use of notes he has prepared, and counsel for defendants makes no objection.)

nication with, the main air or train pipe pressure on one side and the auxiliary reservoir pressure on the other side, so that upon an increase of such pressure in such pipe over that in the auxiliary reservoir, such increased pressure will act upon one side of the piston and force it forward until it is met by an opposing force equal to or greater than that which moved it, when it will come to a stop,
20 and upon a diminution or reduction of such fluid pressure in
the main air or train pipe below that in the auxiliary reservoir, the piston will move backward or in an opposite direction by reason of the preponderance of auxiliary reservoir pressure over that of the main air or train pipe side of the piston. From this it will be seen that the piston will be moved in opposite directions by varying the fluid pressure in the main air or train pipe, and thus the triple valve is controlled accordingly as the pressure in the main air or train pipe is controlled. It will also be seen that, when the pressure upon the opposite sides of the triple-valve piston is equal, that such piston will be held in a state of rest until the equilibrium of pressure is disturbed, when it will move in the direction of least resistance or pressure until the equilibrium is again established or a greater resistance is met.

'or convenience I will call the movement of the piston by reason an increase of fluid pressure in the main air or train pipe, its ward movement or stroke; and the movement of it by a decrease reduction of pressure in the main air or train pipe, its backward vement or stroke; and also I will term the fluid pressure in the in air or train pipe, the main air or train pipe pressure, and that the auxiliary reservoir, the auxiliary reservoir pressure.

The piston chamber and piston of the triple valve illustrated in drawings of patent 360,070 are designated by the numerals 11 d 12 respectively, and the piston is there shown at the extreme it of its forward movement or stroke.

Means are provided in triple valves whereby fluid pressure in the in air or train pipe, or main air or train pipe pressure, is pertted to pass by or through the piston so as to reach both sides reof and act thereon. Usually such passage of fluid pressure es place only when the piston is very near its limit of forward vement, so that upon a reduction of pressure in the main air train pipe below that in the auxiliary reservoir, the passage of fluid pressure from one to the other, in either direction, will be stopped shortly after the beginning of the backward movement of the piston, and the pressure already in the xiliary reservoir is prevented from returning to the main air or in pipe by reason of the closing of such passages by the backrd movement of the piston. The means usually employed for is purpose consist of a valve placed in the piston, which is opened main air or train pipe pressure and closed by auxiliary reservoir essure, or a valve which is opened, or an opening which is unvered by the movement of the piston itself as it nears the limit its forward movement or stroke, and is closed or covered by the ston upon the beginning of its return or backward movement or oke.

In the case last mentioned the valve is usually placed in the ston itself and the opening is located in the wall of the piston amber at the edge of the piston and extending around from one le to the other of it when the piston is at the limit of its forward vement or stroke.

The piston is provided with a valve which controls a suitable ening or port leading from the auxiliary reservoir to the brakelinder, which port or opening is usually closed while the piston passing through the last half or more of its forward movement stroke, and is opened by the backward movement or stroke of the ston.

The piston is also provided with another valve which controls other opening or port leading from the brake-cylinder to the en atmosphere or other desired place of exhaust or escaping fluid essure from the brake-cylinder. This second valve or opening or rt is arranged relatively to the piston, so that the piston causes valve to open the port or opening from the brake-cylinder to atmosphere or other place of exhaust when the piston is near or the end of its forward movement or stroke.

From the above it will be seen that the opening or port leading

from the auxiliary reservoir to the brake-cylinder is always closed when the opening or port from the brake-cylinder to the
22 atmosphere is open and *vice versa*, and also that both of the ports or openings may be closed during a portion of the movement or stroke of the piston.

In many constructions of triple valves, the above two valves connected with the piston and moved thereby are composed of one piece of material which contains suitable recesses to connect the two portions of the ports or openings in the valve chamber or its casing between the points named above, that is, from the auxiliary reservoir to the brake-cylinder and from the brake-cylinder to the open atmosphere or elsewhere. Such is the case in the form illustrated in the drawings of patent No. 360,070, and therein designated by the numerals 14, and which is of the sliding type, and it is held to its seat against one side of the valve chamber constructed in the bushing 24, by a spring resting against the opposite side of such chamber. For convenience, this valve may be termed a main or primary valve because it performs the main or primary functions in applying and releasing the brakes, and is known as a slide-valve. This slide-valve 14, is moved or controlled by a collar 27, and shoulder 28, on the piston stem 13, of the piston 12, as will be seen by referring to the drawings of said patent. The valve chamber in the bushing 24 is in open communication with the auxiliary reservoir through its open end opposite the piston chamber 11, and it is also in communication with the brake-cylinder through the ports or openings 22 and 23 and the passage 16 leading to such cylinder, when the recesses 35 or 31 in valve 14, are in register or communication with the port 23, as one or the other will be during a part of the latter portion of the backward movement or stroke of piston 12. The brake-cylinder is in communication with the release, escape, or exhaust port 15 (see Fig. 2) through passages or openings 16, 22, 23 and 34, when the valve 14 and piston 12 are at or near the extreme limit of their forward movement or stroke, by reason of the recess 33 in such valve furnishing an open passage between ports or openings 33 and 34.

23 The slide-valve 14 is shorter in length than the distance between the shoulder 28 and collar 29 on the piston stem 13, and because of this fact the piston 12 and its stem 13 have a movement relatively to the valve 14. A second stem with a valve 29 is attached to the stem 13 so as to be parallel therewith. Valve 29 has its seat in the slide-valve 14, so that it opens and closes the port or passage 31 leading through the valve 14, and the movement of the stem 13 and the valve 29 attached thereto relatively to the valve 14, permits the opening and closing of the valve 29 without moving the valve 14, except when the move stem 13 exceeds the space between the ends of the valve 14 and collar 29 and shoulder 28 on stem 13, thus relieving the piston of the friction of the valve 14, and rendering the piston 12 more sensitive to slight variations in pressure.

The piston chamber 11 is also in open communication with the main air or train pipe through the passages 17 and 18, leading into

the chamber of the drain-cup portion 19 of the triple-valve casing, and thence through passages 20 to the piston chamber 11.

Arranged axially with the piston 12 and its stem 13 there is another stem 36 fitted in bearings so as to slide freely in the direction of its length, and upon which there is placed a spring 39, which bears at one end against the extreme end of the drain-cup 19, and at its other end against a collar 40 on the stem 36, which collar in turn bears against a bushing 37, arranged in the end of the drain-cup nearest the piston chamber 11. The collar 40 limits the movement of the stem 36 in the direction of the movement of the piston 12, so that there is a space between the end of such stem and a central projection on the piston 12, when the piston is at or near its extreme forward part of its movement, which space is lessened as the piston 12 moves towards the limit of its backward movement or stroke until the projection on the piston 12 comes in contact with the forward end of stem 36 and moves it backward with it through the greater portion of the latter half of the backward movement or stroke of the piston, the compression of the spring
24
39 permitting the stem 36 and collar 40 to move backward with it.

One object of the stem 36 and spring 39 is to prevent the piston 12, when once it starts on its backward movement or stroke, from continuing further than necessary to bring the port or passage 31, in valve 14, in register with the ports and passages 23, 22 and 16, so that auxiliary reservoir pressure can pass into the brake-cylinder when ordinary braking purposes are to be served, as fully set forth in patent 220,556, heretofore referred to. The other object of the stem 36 will be hereafter explained.

The above describes the construction of "triple valves" in general, and also the particular one illustrated in the drawings of the patent in suit.

In reference to the meaning of the term "triple valve," as used in connection with the patent in suit, the specification states that—

"In using the terms 'triple valve' and 'triple-valve device,' I refer to a valve device, however specifically constructed, having a connection with the main air or brake pipe, another with an auxiliary reservoir or chamber for the storage of power, and another with a brake-cylinder, or its equivalent, for the utilization of the stored power, and with a release or discharge passage for releasing the operative power from the brake-cylinder, whether the valves governing these passages or connections are arranged in one or more cases, and are moved by a piston or its equivalent, or by a series of pistons or their equivalents, there being numerous examples in the art, of constructions varying materially in appearance, whereby these functions are performed, both in plenum and vacuum mechanisms."

From the above statement I understand that the form of "triple valve" illustrated in the drawings of the patent in suit is the preferred form, but that any form may be used that the constructor sees fit to adopt in making up the combinations of devices particularly pointed out in the claims named in the question, so long as

such "triple valve" has the three connections and the three-
25 fold functions heretofore referred to, or, in other words, that the particular form which such "triple valve" may take is wholly immaterial, so long as it performs the functions of a "triple valve" as heretofore set forth.

I will now describe those features of construction which, taken in connection with a "triple valve," as defined just above, go to make up the combinations of devices recited in the several claims in the patent in suit and referred to in the present question.

For the purpose of effecting the admission of air from the main air or train pipe to the brake-cylinder when it is desired to apply the brakes with great rapidity and with full force, as, for instance, when a collision or other accident is to be avoided, an auxiliary valve 41 is connected to and moves with the stem 36, which valve, as the stem 36 is moved backward by the contact or connection of the piston 12 with it, as such piston nears its extreme limit of backward movement, uncovers or opens a port or passage 42 in the bushing 37, which opens into a chamber 43, which in turn connects by a passage 46, (Fig. 5) with a chamber 47, in the end of the triple-valve casing adjacent to the auxiliary reservoir. From this latter chamber 47 a passage 48 leads through the auxiliary reservoir to the brake-cylinder. The chamber 43, in the preferred form, is provided with a check-valve 49, which is held to its seat by a spring 50.

This check-valve 49 is arranged so that it is opened by main air or train pipe pressure as it enters chamber 43, whenever such pressure exceeds that of spring 50 and the pressure in the brake-cylinder, and allows it to pass to and through the passage 46, but it is closed whenever the pressure in the brake-cylinder, with the spring 50, exceeds that of the main air or train pipe pressure. From this it results that whenever the train breaks in two, or from any other cause, the pressure is allowed to fully escape from or be greatly reduced in the main air or train pipe, the brakes will be applied by the pressure from the auxiliary reservoir being held in the brake-cylinder by the check-valve 49.

26 When the piston 12 is at the extreme limit of its backward movement or stroke, and the stem 36 has opened or uncovered the port or passage 42 by the backward movement or stroke of the valve 41, there is practically an open passage from the main air or train pipe to the brake-cylinder, through the ports or passages and chambers 17, 18, 20, 11, 42, 43, 46, 47 and 48, so that main air or train pipe pressure can, under certain conditions, pass directly to the brake-cylinder, thereby reducing the pressure in the main air or train pipe and at the same time utilizing it in the brake-cylinder for braking purposes, which results in the application of the brakes to the cars of the whole train in a much shorter time than possible with any other automatic system or construction wholly actuated by fluid pressure before known.

Because of such application of the brakes in a shorter or quicker time, "triple valves" having this capacity of admitting main air or train pipe pressure directly to the brake-cylinder upon the com-

mencement of the application of the brakes, or systems where this result is accomplished, have become known in the art as "quick-action triple valves" or "automatic quick-action systems" of brakes.

Such "quick-action triple valves" or "automatic quick-action systems" of brakes perform three classes of work: First, what is known as "graduating," which is the introduction of an amount of fluid pressure less than the maximum to the brake-cylinders, which will apply the brake-shoes to the wheels of the train with the amount of force which will suffice to prevent the speed of the train from increasing on a downgrade, or reducing the speed of the train when a stop is not to be made, the amount of pressure varying according to the weight of the train, its speed, and the downgrade over which it is passing, or, in other words, the amount of pressure admitted to the brake cylinders is "graduated" according to the circumstances of each particular case.

Second, what are known as "service stops," such as stopping
27 at stations and elsewhere when there is plenty of time, and the least shock or wear and tear on rolling stock is desired; and—

Third, what are known as "emergency stops," that is, stops where collisions or other accidents are to be avoided, and they are to be made in the shortest space of time regardless of other considerations

The first two classes of work are performed more or less perfectly by all known forms or constructions of "triple valves," and the patents numbered 168,359, 172,064 and 220,556, mentioned specifically in the patent in suit have to do with a more perfect performance of said first two classes of work as therein respectively set forth.

The present invention or the invention of the patent in suit has to do with the combining of certain devices with the old automatic system, by means of which the addition or "further function" requisite for "quicker and more efficient action of the brakes is obtained," which function covers the third class of work above referred to, viz., "emergency stops," and these three classes of work are performed when occasion requires, by the use of substantially the same means, each class of work being performed as desired by simply varying the manner of using such means.

The class of work to be performed by the "automatic quick-action system of brakes," or "quick-action triple valves," is determined either by the amount of fluid pressure allowed to escape at the engine from the main air or train pipe or the manner in which such pressure is allowed to escape, or both taken together, as for instance, when "graduating" or holding a train in check on a downgrade or reducing its speed for any reason, is the class of work to be performed, a comparatively small amount of fluid pressure is allowed to escape at a time so that the amount of such pressure which escapes from the auxiliary reservoirs to such cylinders in the operation of equalizing the pressures between such reservoirs and train-pipe, applies the brake-shoes to the wheels of the cars with the desired amount of force. If the first amount of such pressure re-

ceived by the brake-cylinders is insufficient, a second and
28 augmenting amount can be allowed to enter from the auxiliary reservoirs by a still further slight escape from the main air or train pipe, and so on until the desired amount is obtained for holding the train in check or reducing its speed to the desired extent. Again, if the class of work required is a "service" or station stop, a somewhat greater amount of fluid pressure than when graduating is allowed to escape at the engine from the main air or train pipe, but it is allowed to escape gradually, so that the pressure in such pipe decreases as the pressure in the auxiliary reservoirs decreases, the difference in fluid pressure in the auxiliary reservoirs and main air or train pipe remaining about the same, the pressure in each decreasing in like ratio. Or if the train is desired to be stopped more slowly a series of "graduation" applications, or reductions in the pressure in the main air or train pipe can be made and any desired slowness of stoppage of the train can be obtained.

Or again, if the class of work required is an "emergency" stop, when a collision or other accident is to be avoided, then the same or a somewhat less amount of fluid pressure than in making a service stop is allowed to escape at the engine from the main air or train pipe in the shortest possible time, which results in opening communication through each and every quick-action triple valve between the main air or train pipe and the corresponding brake-cylinders throughout the train, and a still further escape of fluid pressure from such pipe at each of such valves to each one of the brake-cylinders is obtained, to be there utilized in applying the brakes. In this latter class of work, that is, making "emergency stops," the quickness with which the pressure is allowed to escape at the engine from the main air or train pipe, determines, in a measure, the amount of fluid pressure which can escape from such pipe before the pressure in the brake-cylinders equals that of the pipe and prevents further escape therefrom to the brake-cylinders.

At or about the time fluid pressure from the main air or
29 train pipe is entering the brake-cylinders, fluid pressure from each one of the auxiliary reservoirs is also simultaneously entering its corresponding brake-cylinder, and in order that the greatest amount possible of the pressure in such pipe shall escape therefrom and enter the brake-cylinders, it is necessary that such cylinders be substantially free from pressure at the beginning of such escape so as to permit the pressure in the pipe to be reduced to the lowest extent before the combined pressures from the main air or train pipe and the auxiliary reservoir, in the brake cylinders, equal that remaining in the pipe, and preclude the further escape from the pipe to the cylinders, as the escape ceases on the approach of an equilibrium between the pressures in the cylinders and the pipe.

From the above it follows as a necessity that the fundamental or underlying principle of the "automatic quick-action system" of brakes, requires that the brake-cylinders be substantially free from pressure, and that the escape of fluid pressure from the main air or train pipe at the engine, be quick and considerable in extent,

so that communication between the main air or train pipe and the brake-cylinders be opened almost instantaneously, and before any substantial opposing pressure has entered the cylinders from the auxiliary reservoirs to interfere with the escape of pressure from the main air or train pipe to such cylinders.

The quickness of action of the brakes on succeeding cars, as well as the increased force with which the brakes are applied, depends almost wholly upon the amount of fluid pressure escaping from the main air or train pipe into the brake-cylinder of each preceding car.

To illustrate, we will assume that the relative proportions of all the parts are such as will give the following results, which are approximately those obtained in actual practice in some systems where "quick-action triple valves" are used. When the fluid pressure in the main air or train pipe is seventy pounds to the square inch and an emergency stop is to be made, the auxiliary
30 reservoir pressure, owing to the connection between them and the main air or train pipe, will also be seventy pounds, as the two pressures equalize through such connection. Then the engineer allows twenty pounds to quickly escape from the main air or train pipe by means of his operating cock or valve, and opens communication between the main air or train pipe and the brake-cylinder of the first quick-action triple valve, or such valve nearest the engine, when the pressure in such pipe adjacent to such valve is almost instantaneously reduced to about forty pounds, such reduction of pressure entering the cylinder, and it is sufficient to exert a pressure therein of about twenty-five pounds, which, with the pressure from the auxiliary reservoir, entering simultaneously, or nearly so, with that from the main air or train pipe, balances or equalizes the pressures in the cylinder and pipe, and further escape from such pipe at that point ceases.

Adjourned to meet at same place, tomorrow, Wednesday, July 15th, 1891, at eleven o'clock a. m.

R. H. WHITTLESEY,
Special Examiner.

NEW YORK, N. Y., *July* 15, 1891

Met pursuant to adjournment.
Counsel present as at yesterday's meeting.

The witness, HENRY F. NEWBURY, continues his answer to Int. 4:

This reduction of pressure to forty pounds in the main air or train pipe adjacent to the first triple valve causes the second triple valve to open communication between such pipe and the second brake-cylinder, and cause a second escape like that at the first triple valve, and this is repeated in succession until the end of the
31 train is reached and the pressure in the entire pipe throughout the train is reduced to about forty pounds, and each brake-cylinder has received a pressure from such pipe of about

twenty-five pounds without the fluid pressure traveling from one end of the train to the other, each reduction being adjacent to its point of escape and the quickness of the application of the brakes on the several cars being in proportion to the amount of escape of fluid pressure from such main air or train pipe. The maximum equalized pressure in the auxiliary reservoirs and cylinders, when a service or station stop is made, and no pressure is received directly from the main air or train pipe, is about fifty pounds; and it will be readily seen that the equalized pressure in the case of an emergency stop, when the brake-cylinders have received a pressure of about twenty-five pounds from such main air or train pipe, will be considerably higher than it would be if no pressure had been received from the main air or train pipe, and such equalized pressure in the case of an emergency stop is about sixty pounds to the square inch instead of about fifty pounds when a service stop is made; or, in other words, the brake-shoes are applied to the wheels of the cars with about ten pounds more force in case of an emergency stop than when a service stop is made. In the above illustration I have used round numbers for convenience; but, as before stated, they approximate actual results in practice.

With the above understanding of the operation of triple valves, when used in the "automatic quick-action" system of brakes in general, I will describe the operation of the preferred form illustrated in the drawings and which I have fully described the construction thereof.

Compressed air is the fluid designed to be used in such preferred form as is stated in those portions of the specification which I have heretofore quoted.

To aid in the said description, I will make reference to a drawing on an enlarged scale showing the arrangement of the quick-
32 action triple valve, auxiliary reservoirs, and brake-cylinder, and the several connections to which I have heretofore referred, which arrangement will be found in that portion of the drawing designated as Fig. 1. Figure 2 on the same drawing represents a sectional view of the triple valve and its connection to the main air or train brake-pipe, taken on a different line from that on which corresponding portions are shown in Fig. 1, the object being to more clearly show the construction and arrangement of the auxiliary-valve device, by means of which communication is opened directly from the main air or train pipe into the brake-cylinder. I will place on the said drawing the same designating characters that are found on the patent in suit.

I will hereafter and before the close of my present deposition produce a cut or drawing showing the general arrangement of the air-compressing device and other parts located upon the engine, as well as one of the old forms of triple valves, and also one form of quick-action triple valve of the patent in suit, as the same are arranged in actual practice, so as to show the connections between the locomotive and train.

For convenience I will describe the operation of this automatic quick-action system of brakes when performing the two first classes

of work heretofore referred to—namely, "graduating" and "service" stops—together.

The drawing referred to by the witness is here offered and put in evidence by counsel for complainants and is marked "Complainants' Exhibit Drawing Complainants' Quick-action Triple Valve and Connections, R. H. Whittlesey, special examiner."

In the operation of such automatic quick-action system of brakes, as the same is illustrated in the drawing of the patent in suit, air from the main reservoir and main air or train pipe passes through passages 17, 18, chamber in drain-cup 19, and passages 20, into the piston chamber 11, forcing the piston 12 forward to the ex-
33 tremity of its movement or stroke in that direction and uncovering a small feeding groove or opening 51 in the piston chamber, leading around the piston, through which compressed air or fluid pressure passes into auxiliary reservoir 6 until the pressure in the latter is equal to that in the main air or train pipe, the brake-cylinder meanwhile being in communication with the atmosphere through passages 16 and 22, recess or opening 33 in valve 14, and ports 23, 34 and relief or exhaust port 15. To apply the brakes in making service or other ordinary stops, a portion of the air or pressure is discharged from the main air or train pipe by the engineer's valve, thereby reducing the pressure in said main air or train pipe, whereupon the higher or greater pressure in the auxiliary reservoir moves the piston 12 backward a portion of its stroke, closing or covering the opening or feeding groove 51, and thus preventing the return of air or pressure from the auxiliary reservoir to the main air or train pipe, the movement of the piston continuing until arrested or stopped by the decrease of pressure in the auxiliary reservoir or by its contact with the stem 36 and its spring 39.

This movement of the piston 12 backward, under the conditions and to the extent just named, may be termed its first or preliminary movement or traverse.

The movement of the slide-valve 14 then closes the port 23, preventing escape of air or pressure from the brake-cylinder, and places the passage 31 partly or wholly in communication or register with the recess or opening 33.

The valve 29, which opens and closes the passage 31 in the valve 14, having been meanwhile unseated by the movement of the piston stem 13, opens such passage so that compressed air or pressure from the auxiliary reservoir passes through port 32 and passage 31 of the slide-valve 14, and the passages 22 and 16 of the triple-valve casing or chest to the brake-cylinder, forcing out the piston of such cylinder and through an appropriate system of levers and connections applying the brakes to the cars. When the pressure in the auxil-
34 iary reservoir has in this operation been reduced by expansion into the brake-cylinder until it is slightly below the pressure in the main air or train pipe the pressure on the main air or train pipe side of the piston 12, forces such piston in the opposite or forward direction until the valve 29 closes the passage 31, thereby arresting or stopping the further flow or expansion of air or pressure

from the reservoir to the brake-cylinder and holding the brakes with a force proportionate to reduction of pressure in the main air or train pipe.

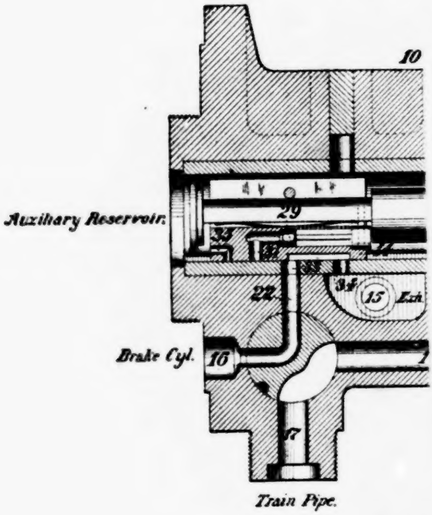
To release the brakes, the pressure in the main air or train pipe is increased by admitting pressure or air from the main reservoir located upon the engine, whereupon the resultant increase of pressure in the piston chamber 11 forces the piston forward to the extreme limit of its stroke in that direction, permitting the escape of air from the brake-cylinder 7. The piston 52 of such cylinder is returned to its former position by a spring 53, releasing in such movement the brake-shoes 9 from the wheels, and at the same time the auxiliary reservoir is recharged. The admission of fluid pressure or air to the brake-cylinder through the passage 31, in the valve 14, which is opened just before the piston stem 13 comes in contact with graduating stem 36, and which corresponds to the feeding passage heretofore employed, suffices for all ordinary requirements for applying the brakes in regular service, that is, the first two classes of work heretofore referred to are performed by the operation of the triple valve, as just heretofore described.

(Here follow diagrams marked pp. 34*a* & 34*b*.)

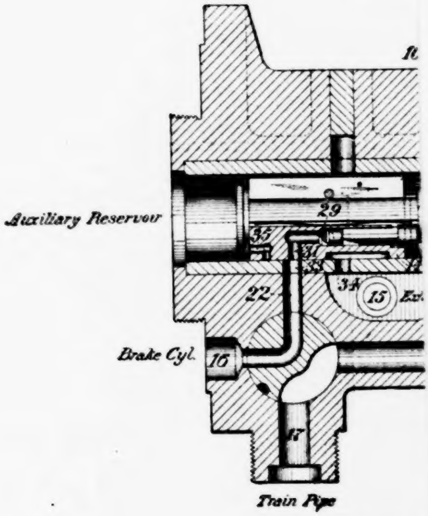
In the event, however, of its becoming necessary to apply the brakes with great rapidity and with the greatest available force, as for instance, when an "emergency stop" is to be made, the engineer, by means of the operating valve at his command, instantly discharges sufficient air from the front end of the main air or train pipe to effect a sudden reduction of pressure therein, as heretofore described, whereupon the piston 12 is forced to the extreme limit of its backward movement or stroke, carrying with it the stem 36, and auxiliary slide-valve 41, which instantly opens or uncovers the port or opening 42, and opens communication between the main air or train pipe and brake-cylinder through the opening in the check-valve 49 and the passages 46, 48, leading thereto, and permitting fluid pressure or air to escape directly from such pipe to the brake-cylinder, while such cylinder is substantially free from pressure, and before fluid pressure or air has entered said cylinder from the auxiliary reservoir in sufficient quantity to materially interfere with the escape from the pipe to the cylinder. When each car of the train is provided with one of these devices it will be seen that they are successively moved with great rapidity, there being practically, in a train of fifty cars, fifty openings for discharging fluid pressure or air from the main air or train pipe, instead of the single opening heretofore commonly used. Not only is there a passage of considerable size, relatively to that of the opening or passage leading from the auxiliary reservoir to the brake-cylinder, opened from the main air or train pipe on each car, whereby the pressure is more quickly reduced, but the pressure or air so escaping from such pipe to the brake-cylinders is utilized in the performance of applying the brakes, as heretofore explained in connection with the action of quick-action triple valves in general.

Complainai

Rel



Servi



Quick A

FOLDOUTS TOO LARGE TO
BE FILMED

In the preferred or illustrated form, when the piston 12 arrives at the extremity of its backward stroke or movement as above specified, a supplemental port or opening 35 of the slide-valve 14 is brought into communication or register with the port or opening 23 and passages 22 and 16, which serves to discharge or permit the escape of the auxiliary reservoir pressure into the brake-cylinder at or nearly simultaneously with the pressure entering such cylinder directly from the main air or train pipe, thus augmenting the pressure exerted by the direct admission of pressure or air from such pipe. Upon the reduction of the pressure in the main air or train pipe below that in the brake-cylinders, as by the breaking in two of the train or the bursting of a pipe, check-valve 49 closes communication between the passages 46 and 18, thereby pre-
36 venting the escape of pressure or air from the brake-cylinder to the main air or train pipe, and holding such pressure or air in the cylinder to be utilized in applying the brakes.

The movement or stroke of the piston 12 beyond the point where the two first classes of work, as heretofore explained, are performed, and which two classes of work are performed by what I have termed the first or preliminary movement or traverse of the piston, and which further movement of the piston 12 actuates the auxiliary valve device 41 by the backward movement of the stem 36, I will term the second or further movement or traverse of the piston 12, it being the movement which opens direct communication between the main air or train pipe and the brake-cylinders.

Claim 1 of the said patent in suit reads as follows:

"1. In a brake mechanism, the combination of a main air pipe, an auxiliary reservoir, a brake-cylinder, a triple valve and an auxiliary valve device actuated by the piston of the triple valve and independent of the main valve hereof, for admitting air in the application of the brake directly from the main air pipe to the brake cylinder, substantially as set forth."

Said claim 1 when read in light of the specification, as I understand the matter, is composed of five essential elements or devices combined together to form a brake mechanism, which elements or devices are as follows:

a. A main air or train pipe adapted to connect with a source of fluid pressure or air supply and a triple valve.

b. A reservoir adapted to be connected with the source of fluid pressure or air supply through a triple valve, and also adapted to be attached to a car.

c. A brake-cylinder provided with a piston and means for
37 connecting the same with the brake-shoes of the wheels of the car.

d. A triple valve having the capacity of performing the ordinary functions of such a valve, such as performing the two first classes of work heretofore referred to, and adapted to actuate an auxiliary valve device through contact with, or a connection of the piston with some portion of such valve device.

e. An auxiliary valve device adapted to open direct communication between the main air or train pipe and the brake-cylinders,

and which is independent of the valve which performs the main or primary functions in applying and releasing the brakes, and is also adapted to be actuated in one direction by reason of contact, or a connection between the piston of the triple valve and the auxiliary valve device.

The above-named five essential elements or devices when combined, as above indicated and set forth in the specification of the patent in suit, form an automatic quick-action system of brakes for a single car, and contain the essential elements particularly set forth or pointed out in said claim 1.

Claim 2 of this same patent is in the following language:

"2. In a brake mechanism, the combination of a main air pipe, an auxiliary reservoir, a brake-cylinder, and a triple valve having a piston whose preliminary traverse admits air from the auxiliary reservoir to the brake-cylinder, and which by a further traverse admits air directly from the main air pipe to the brake-cylinder, substantially as set forth."

This claim 2, when read in the light of the specification as I understand the matter, is for a combination of four essential elements or devices combined together to form a brake mechanism, and such essential elements or devices are as follows:

38 The first three elements or devices of this second claim are substantially the same as the first three of claim 1, and therefore I will not repeat them.

d. A triple valve provided with a piston and a valve mechanism, the piston having two movements or traverses, one greater in extent than the other, the greater one including the lesser, the first or preliminary movement or traverse of such piston operating the valve mechanism for the admission of fluid pressure or air from the auxiliary reservoir to the brake-cylinder, to perform the functions of an ordinary triple valve in the first two classes of work heretofore referred to, and the second or further movement or traverse of the piston operating the valve mechanism so as to open communication between the main air or train pipe and the brake-cylinder for the direct admission of fluid pressure or air from such pipe to such cylinder to perform the third class of work heretofore referred to.

The above four essential elements or devices when combined as above indicated, and as set forth in the specification, form a brake mechanism for use in the automatic quick-action system of brakes, and contain the essential elements or devices particularly pointed out in said claim 2.

Claim 4 of the patent in suit is as follows:

"4. The combination in a triple-valve device of a case or chest, a piston fixed upon a stem, and working in a chamber therein, a valve moving with the piston stem, and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere respectively, and an auxiliary valve actuated by the piston stem and controlling communication between passages leading to connections with a main air pipe and with the brake-cylinder respectively, substantially as set forth."

39 Said claim 4, when read in the light of the specification, as I understand the matter, is for the combination of the following four essential elements or devices, in a single casing or chest, to form a quick-action triple valve.

(*a*.) A casing or chest provided with a chamber adapted to receive a piston and have the same work therein, and provided with ports or passages leading to connections adapted to connect with an auxiliary reservoir, a brake-cylinder and the atmosphere, and also provided with passages leading to connections adapted to connect with a main air or train pipe and a brake-cylinder.

(*b*.) A piston fixed upon a stem and adapted to work in a chamber in the casing or chest, and also to actuate an auxiliary valve.

(*c*.) A valve adapted to be moved by the piston and to govern or control the ports and passages in the casing or chest leading to the connections with an auxiliary reservoir, a brake-cylinder and the atmosphere.

(*d*.) An auxiliary valve adapted to control or govern communication between the passages in the casing or chest leading to the connections with a main air or train pipe and a brake-cylinder.

The above four essential elements or devices when combined as above indicated and set forth in the specification, form a mechanism in a single casing or chest which is capable of performing, when properly connected as stated, the three classes of work heretofore referred to, and the same is known in the art as a quick-action triple valve, and it contains the essential elements or devices particularly pointed out in said claim 4 of the patent in suit.

Int. 5. Have you examined Complainants' Exhibit Defendants' Quick-action Triple Valve, and compared the same with plate XI, and the description thereof in Complainants' Exhibit Defendants' 1891 Catalogue?

40 A. I have carefully compared said defendants' quick-action triple valve with plate XI of said defendants' 1891 catalogue, and find the said valve to substantially correspond with said plate.

Int. 6. Will you please describe briefly and generally the construction and operation of Complainants' Exhibit Defendants' Quick-action Triple Valve, and in making such description refer to Complainants' Exhibit Defendants' 1891 Catalogue where you may find the same pertinent?

A. I will at this point state, as a result of my comparison of the said Exhibit Defendants' Quick-action Triple Valve with plate XI in said defendants' 1891 catalogue that I found the following differences:

1st. In the place of the passage B, shown in said plate, as leading from the chamber C to the piston chamber D, back of the triple-valve piston 29, there was a limited space left between the hollow triple-valve piston stem and bushing 9, which permitted fluid pressure to pass from the chamber C, between such piston stem and bushing 9, into the piston chamber D, and from thence into the auxiliary reservoir through the passage A. This limited space or looseness of the hollow piston stem and the bushing 9, was supple-

mented by two shallow grooves leading from the chamber C, along such piston stem to within about a quarter of an inch of piston 29, so that when the ends of such grooves nearest the piston 29 were moved through and beyond the bushing 9 by the backward movement of the piston 29, such grooves, when thus moved, permitted a greater escape or passage of fluid pressure from such piston chamber D into the chamber C than was possible with the slight space or looseness heretofore referred to between the hollow piston stem and such bushing 9.

The result of this difference in the construction between said defendants' quick-action triple valve and the one shown in said plate XI, is that the auxiliary reservoir will be charged more slowly, when the construction is that of said defendants' quick-action triple valve, than would be the case when the construction was
41 that of said plate XI; but this difference would not otherwise change the operation, and, in my opinion, it would not materially effect the combinations shown in said plate XI.

It will also be observed that the screw-plug, designated as 4 in the chamber E of said plate XI, is missing from said defendants' quick-action triple valve, but the hole for such plug is now present. There is also in said defendant's quick-action triple valve a hole made in the casing or chest opposite the chamber C, which is not found in said plate XI, and which, I understand, would not be present in said quick-action triple valve when put into actual practice.

These last two differences, like the first one mentioned, do not materially affect the questions at issue, because it is manifest that the said screw-plug 4 could be readily supplied, and the hole through the casing or chest be stopped up, and thus place the said quick-action triple valve in condition, when the proper connections are made, to be wholly operative in the manner in which the valve of said plate XI is operative.

For convenience of marking the several operative parts, I will use said plate XI in my description of said Exhibit Defendants' Quick-action Triple Valve.

The said Exhibit Defendants' Quick action Triple Valve is a mechanism having the capacity of performing the three classes of work heretofore referred to by me, viz., "graduating," making "service stops" and also "emergency stops;" and, like all triple valves, is provided with a casing or chest, which has a piston chamber in which a piston works, which piston is provided with a stem and a valve mechanism, by means of which, upon the variation of fluid pressure in the main air or train pipe, the three connections, heretofore referred to, with the threefold function, is adapted to be made and performed.

Said quick-action triple valve is adapted to be connected with the main air or train pipe by the connection designated as 1 on said plate XI, which plate will also bear the designating characters hereafter referred to in my description of the said defendants' quick-
42 action triple valve. The casing or chest of the said defendants' quick-action triple valve is adapted to be connected

with an auxiliary reservoir, by attaching the same thereto, so that the passage A registers with an opening in such reservoir, and the said casing or chest is also adapted to be connected to the brake-cylinder by securing such casing or chest to such cylinder, so that the passages *h h* will register with suitable openings in such cylinder; said casing is also provided with the passage G, leading to the atmosphere.

The manner in which these connections may be made with the said triple valve, auxiliary reservoir, and brake-cylinder will be found in plate X of said Exhibit Defendants' 1891 Catalogue, wherein 1 is the auxiliary reservoir, and 2 the brake-cylinder, and the quick-action triple valve is designated as "quick-action valve," and the point at which the connection is made between the main air or train pipe is designated "to train-pipe."

For the better illustration of these several connections, I produce a drawing with the above-named several parts arranged in substantially the same manner as in the said plate X, but with the quick-action triple valve also in section. This arrangement will be found in Fig. 1 of said drawing, which, it will be observed, is upon a much enlarged scale than that of said plate X.

Fig. 2 of said drawing is a cross-sectional view of the quick-action triple valve shown in Fig. 1, but taken upon another line, so as to show the same connected to the auxiliary reservoir as the same would be shown when such quick-action triple valve is made on the same section line as that on which said plate XI is made upon, and which would be at right angles to that on which said valve is shown in Fig. 1.

Counsel for complainants offers and puts in evidence the drawing referred to by the witness, and the same is marked "Complainants' Exhibit Drawing Defendants' Quick-action Triple Valve and
43 Connections, R. H. Whittlesey, special examiner."

The casing or chest of the said quick-action triple valve, as the same is represented in said plate XI, is provided with ports or passages leading from the main air or train pipe to the auxiliary reservoir and then to the brake-cylinder, and from thence to the atmosphere. Said casing or chest is also provided with ports or passages leading from the main air or train pipe directly to the brake-cylinder.

The said casing or chest is provided with a piston chamber designated as D, in which a piston 29 works forward and backward, as the case may be, leaving a space or portion of such chamber on each side of the piston. That portion of the piston chamber D, which is nearest the connection with the main air or train pipe I will call the main air or train pipe portion, and the portion nearest the connection with the auxiliary reservoir I will call the auxiliary reservoir portion.

The piston 29 is provided with a hollow piston stem, in which a check-valve 26 works, so that the opening or passage F through such stem is opened by the unseating of the check-valve 26, whenever the main air or train pipe pressure exceeds that in the chamber

C, openings being made in such hollow piston stem leading into such chamber C. A spring 27 is arranged to hold the check-valve 26 seated when the main air or train pipe pressure is slightly less than that in the chamber C and the added pressure of the spring 27, or when the two pressures are equal.

This hollow piston stem is closed at its inner end or the end nearest the auxiliary reservoir and brake-cylinder, and to this closed end there is attached a valve 17–18, the portion 18 being provided with ports or openings *i*, *j*, which are connected together by a passage *k*, shown in dotted lines in said plate XI. The portion 17 of this valve 17–18 moves back and forth in a cylindrical or tubular recess designated *l*, which recess has a port or opening leading into the passage G, and when the piston 29 is in the position shown in said
44 plate XI, which is the extreme limit of its forward movement or stroke, this port or opening is open, so that the portion of the recess *l* nearest the piston stem is in communication with the passage G, and when the piston begins its backward movement this port or opening is closed and such communication is shut off.

Adjourned to meet at same place tomorrow, Thursday, July 16, 1891, at 10.30 a. m.

R. H. WHITTLESEY,
Special Examiner.

NEW YORK, *July 16th*, 1891.

Met pursuant to adjournment.
Counsel present as at last meeting.

The witness HENRY F. NEWBURY continues his answer to Int. 6:

It will be observed that this cylindrical or tubular recess *l* opens into the chamber H, which communicates with the brake-cylinder through the passages *h h*, so that the brake cylinder is in open communication with the atmosphere through the passages *h h*, chamber H, recess *l*, the port or opening leading therefrom to the passage G, and thence through such passage to the atmosphere.

The valve 17–18, as it is moved with the piston 29, passes through a valve 22, and moves therein during the greater portion of such backward and forward movement, and, as a result of such movement of the valve 17–18, in and through the valve 22, the port or opening *i* is either moved out from such valve 22, so as to open communication between such port and the chamber C, upon the backward movement of the piston 29, when the port *i* is withdrawn from the valve 22 and placed in communication with the chamber C, or moved into such valve 22, so as to close communication between the port or opening *i* and the chamber C, upon the
45 forward movement or stroke of the piston 29, when the port or opening *i* enters the valve 22 and closes communication with the chamber C. When the port *i* is withdrawn from the valve 22, as just described, the chamber C is in communication with the chamber H, through the port or opening *i*, passage *k* leading there-

from to the port or opening *j*, and from such chamber H to the brake-cylinder through the passages *h h*.

The valve 22 will be held to its seat, as shown in plate XI of said defendants' 1891 catalogue, whenever the pressure in the chamber C exceeds or equals that in the chamber H. It will be observed that the area of surface of valve 22, exposed to the action of fluid pressure, is greater upon the side of the valve adjacent to the chamber C than its opposite side, which is adjacent to the chamber H, and because of this fact said valve 22 will be held to its seat when the pressures are equal on its two sides, owing to the excess of area to be acted on by the fluid pressure on that side adjacent to chamber C.

The piston, 29, as it nears the extreme limit of its backward movement or stroke, lifts the valve, 22, from its seat by reason of the contact of the collar, *m*, attached to the portion, 18, of the valve, 17–18, coming into contact with the side of the valve, 22, adjacent to the chamber, H, before the piston, 29, has reached the extreme limit of its backward movement, and upon the further movement or traverse of the piston, 29, in a backward direction, after the collar, *m*, has come in contact with valve 22, such valve then partakes of the movement of the piston, 29, and its stem, to which the valve, 17–18, is secured.

When the valve, 22, is lifted from its seat upon the piston, 29, reaching the extreme limit of its backward movement, the chamber C is in open communication with the chamber H, through the port or opening made between the valve, 22, and its seat, which port or opening is several times the size of the passage, B, leading
from the chamber, C, to the auxiliary reservoir portion of the
46 piston chamber, D, and thence through such portion of
chamber, D, and passage, A, to the auxiliary reservoir.

From the above it will be seen that the casing or chest is provided with ports and passages leading from the connection, 1, with the main air or train pipe through the chamber, E, the main air or train pipe portion of the piston chamber, D, passage, F, in the hollow piston stem, past the check-valve, 26, into the chamber, C, thence through the passage, B, into and through the auxiliary reservoir portion of the piston chamber, D, and passage, A, to the auxiliary reservoir.

From the auxiliary reservoir, the passages and ports in the casing or chest of said defendants' quick-action triple valve lead backward through the passage A, auxiliary reservoir portion of the piston chamber D, passage B, into the chamber C, and from thence through the port or opening *i*, passage *k*, and port or opening *j*, in the valve 17–18, through the chamber H and passages *h h* into the brake-cylinder. From the brake-cylinder, the passages and ports in the casing or chest of said defendants' quick-action triple valve lead backward through the passages *h h* into chamber H, and from thence through the cylindrical recess *l* and port or opening leading therefrom into the passage G to the atmosphere. The above-named passages and ports in the casing or chest of said defendants' quick-action triple valve give such valve a connection with the main air or train pipe,

another with an auxiliary reservoir, and another with a brake-cylinder, for the utilization of fluid pressure or air in the application of the brakes, and a release or discharge passage for releasing the operative fluid pressure or air from the brake-cylinder, thus giving said defendants' quick-action triple valve the three connections essential for the operation of a triple valve in performing the two first classes of work heretofore referred to by me, and when such two classes of work are performed the threefold function heretofore named is also performed.

The casing or chest of said defendants' quick-action triple valve is also provided with passages and ports leading from the
47 connection 1 with the main air or train pipe, through the chamber E and the main air or train pipe portion of the piston chamber D, passage F in the hollow stem of piston 29, past the check-valve 26, into the chamber C, through the port or opening between the valve 22 and its seat, into the chamber H, and through the passages *h h* into the brake-cylinder.

These latter passages and ports open communication directly from the main air or train pipe to the brake-cylinder, and main air or train pipe pressure is thereby admitted directly to the brake-cylinder without first passing into the auxiliary reservoir, thus giving said defendants' quick-action triple valve the capacity of performing the third class of work heretofore referred to, wherein the brakes are applied to the wheels of the car in a much quicker or shorter space of time and with greater effective force than when the two first classes of work heretofore referred to are performed.

The valve 17–18 of said defendants' quick-action triple valve is so arranged relatively to the piston 29, that the port or opening leading from the cylindrical or tubular recess *l* to the passage G, upon the beginning of the backward movement of such piston by the portion 17 moving over and past such port or opening and closing or shutting it off from such recess *l*, during the rest of the backward movement of the piston, whatever that may be. This closing or shutting off of this port or opening by the backward movement of the piston 29 and the valve 17–18 is accomplished before the port or opening *i* and the valve 17–18, is moved so as to open into the chamber C, by passing beyond the valve 22 through which it moves, so that recess *l* is shut off from the atmosphere before fluid pressure can enter the port or opening *i*, from the chamber C, and the pressure so entering the chamber H passes into the brake-cylinder and is held there to be utilized in applying the brakes.

The operation of the said Exhibit Defendants' Quick-action Triple Valve is as follows, when the connections are made with the main air or train pipe, auxiliary reservoir and brake-cylinders, as the same is adapted to be connected as I have heretofore stated:

48 Main air or train pipe pressure entering the chamber E exerts its force on the piston 29, forcing it forward to the extreme limit of its movement or stroke in that direction and causing the portion 17 of the valve 17–18, to open the port or opening lead-

ing from the recess l to the passage G, thus permitting any fluid pressure in the brake-cylinder to escape to the atmosphere, when such main air or train pipe pressure will lift the check-valve 26 off from its seat and enter the chamber C, pass through the passage B and the auxiliary reservoir portion of the piston chamber D into the auxiliary reservoir through the passage A, until the fluid pressure in the auxiliary reservoir, and the pressure exerted by the spring 27, closes the check-valve 26, by reason of the substantial equalization of the pressures in the main air or train pipe and the auxiliary reservoir.

The forward movement of the piston 29, and the excess of pressure in the chamber C over that in the chamber H, causes the valve 22 to be seated, if, for any reason it had not become so, upon the forward movement of the piston; and the port or opening i, in the valve 17–18, is moved into valve 22, so that communication between chambers C and H, either through the valve 17–18 or the valve 22, is thereby closed.

In this condition the said "defendants' quick-action triple valve" would be in what is known as "running order," that is, ready to apply or release the brakes and perform any one of the three classes of work heretofore referred to as occasion might require.

To apply the brakes and perform either one of the two first classes of work heretofore referred to, the engineer would allow fluid pressure to escape from the main air or train pipe, by means of his operating valve or cock to the extent desired, and thus reduce the pressure in such pipe below that in the auxiliary reservoir, when the greater pressure on the auxiliary reservoir side of the piston would force such piston backward, causing the portion 17 of the valve 17–18 to close communication between the brake-cylinder and the atmosphere, and such backward movement of the
49 piston 29 would be sufficient to cause the port or opening i
in the valve 17–18 to move out of the valve 22, and open communication between the chambers C and H, for the admission of fluid pressure from the auxiliary reservoir to the brake-cylinder through the passage A, to the auxiliary reservoir portion of the piston chamber D, thence through the passage B, chamber C, port or opening i, passage k, port or opening j, into the chamber H, and thence through the passages h h into the brake-cylinders, and the admission of fluid pressure from the auxiliary reservoir in the brake-cylinder will continue until the auxiliary reservoir pressure is slightly less than that of the main air or train pipe, when the preponderance of pressure upon the main air or train pipe side of the piston 29 will cause it to move forward a distance sufficient to cause the port i of valve 17–18 to enter the valve 22, and shut off communication between the auxiliary reservoir and brake-cylinder, but not a distance sufficient to open the brake-cylinder to the atmosphere.

The amount of fluid pressure allowed to enter the brake-cylinder in performing these two classes of work, as before explained, is determined by the amount of pressure allowed to escape slowly at one

time from the main air or train pipe at the engine by means of the engineer's cock or valve.

To release the brakes, fluid pressure is allowed to enter the main air or train pipe from the main reservoir upon the engine by means of the engineer's cock or valve, thus increasing the main air or train pipe pressure above the auxiliary reservoir pressure, when the preponderance of pressure upon the main air or train pipe side of the piston 29 causes such pision to move forward to the extreme limit of its movement in that direction, opening the brake-cylinder to the atmosphere by the movement of the portion 17 of the valve 17–18 in the recess *l*, far enough to open the port or opening leading from such recess to the passage G and permitting the pressure in the brake-cylinder to escape to the atmosphere and move
50 the brake-cylinder piston backward and through the connections of such pistons with the brake-shoes, relieving the wheels of the cars from the presence of such shoes, thus releasing the brakes and at the same time opening the check-valve 26 and recharging the auxiliary reservoir with pressure equal to that in the main air or train pipe.

The said defendants' quick-action triple valve has the capacity of performing the second class of work namely, making "service stops," by making a series of "graduating" applications, that is, allowing fluid pressure to escape from the main air or train pipe, a little at a time instead of continuously, until the fluid pressure admitted to the brake-cylinders from the auxiliary reservoirs is sufficient to apply the brakes to the extent necessary to stop the train. The difference between making a "service stop" by a series of "graduating" applications, instead of by a continuous and slow escape of pressure from the main air or train pipe, is that the brake-cylinder receives a series of augmenting admissions of fluid pressure from the auxiliary reservoir, instead of a continuous admission, and that, in making a stop by a series of "graduating" applications, that such stop is made more slowly, owing to the fact of time elapsing between each two of a series of "graduating" applications.

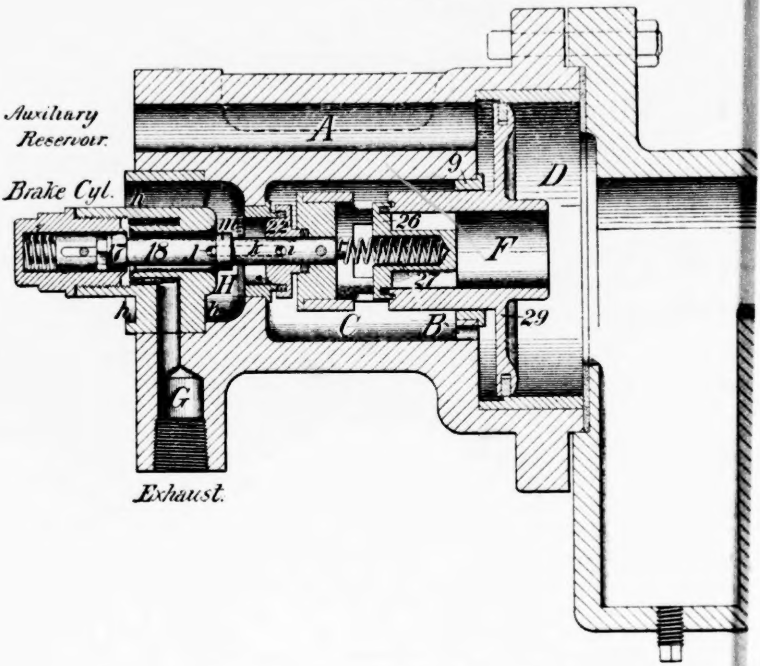
From the above it will be seen that the valve 17–18 performs the ordinary functions of a "triple valve" as heretofore explained; that is, it performs the main or primary functions in applying and releasing the brakes, and because of this fact, it may be correctly and fitly termed the main valve of the said Exhibit Defendants' Quick-action Triple Valve, and I will so term it.

(Here follow diagrams marked pp. 50*a* & 50*b*.)

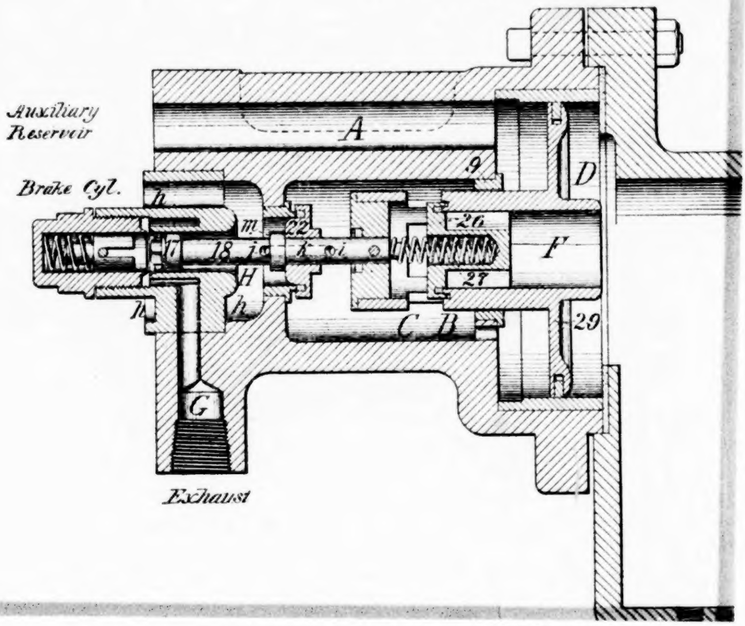
To apply the brakes in the quickest or shortest possible time and with greater force than when a service stop is made, as heretofore described with said defendants' quick-action triple valve, the engineer allows a considerable amount of fluid pressure, equal to, or somewhat less than, the amount allowed to escape when making a "service stop," to quickly escape from the main air or train pipe, which results in the almost instantaneous backward move-
51 ment of the piston 29 to the extreme limit of its movement

Plate XI. Defendants' 1891 Catalogue.

Release Position.



Service Application.



FOLDOUTS TOO LARGE TO
BE FILMED

or stroke in that direction, causing the collar *m* on the portion 18 of the valve 17–18 to contact with the valve 22 and remove it from its seat, the portion 17 of the valve 17–18 meanwhile closing communication between the brake-cylinder and the atmosphere. As a result of unseating the valve 22 as just described, fluid pressure in the chamber C immediately escapes or expands into the brake-cylinder, and owing to the fact that the port or opening between the valve 22 and its seat being of much greater size or capacity than the passage B leading from said chamber C to the auxiliary reservoir, the fluid pressure in the chamber C escapes or expands into the brake-cylinder much faster than it can enter such chamber from the auxiliary reservoir, and as the escape from the chamber C takes place when the brake-cylinder is substantially free from such pressure, it results that pressure in the chamber C is reduced far below that in either the auxiliary reservoir or the main air or train pipe. Owing to the fact that the pressure in the chamber C is reduced far below that in the main air or train pipe, the check-valve 26 is immediately moved from its seat by the greater force exerted by the main air or train pipe pressure, opening communication between the main air or train pipe and brake-cylinder for the direct admission of fluid pressure or air from such pipe to the brake-cylinder, and such admission will continue until the combined pressures entering the brake-cylinder from the auxiliary reservoir simultaneously with that from the main air or train pipe is slightly less than the reduced pressure in such main air or train pipe, when the check-valve 26 will become seated owing to the action of the combined pressures being the same in the chamber C that they are in the brake-cylinder by reason of large port or opening made between the valve 22 and its seat when such valve is unseated as before described. Upon the closure of the check-valve 26, the escape or expansion of main air or train pipe pressure ceases and the further reduction of such pressure also ceases. This direct ad-
52 mission of fluid pressure from the main air or train pipe to the brake-cylinder necessarily reduces the pressure largely in such pipe adjacent to the quick-action triple valve through which the expansion took place, and as a result of such reduction of the pressure in the main air or train pipe at this point, the next quick-action triple valve will be caused to operate in like manner and cause a still further reduction of pressure in such pipe adjacent to such next quick-action triple valve, which in turn would, in like manner, cause the next adjacent quick-action triple valve to repeat this operation, and so on throughout the train, each car of which is supplied with quick-action triple valves like that of said Exhibit Defendants' Quick-action Triple Valve, and thus the pressure in the main air or train pipe throughout the length of the train is reduced without such air traveling from the rear of the train to the engine, there being as many openings for the escape of fluid pressure or air as there are quick-action triple valves connected with the main air or train pipe. The escape of fluid pressure directly from the main air or train pipe to the brake-cylinders is therein utilized in applying the brakes. Upon the closing of the check-valve 26, fluid

pressure from the auxiliary reservoir continues to expand into the brake-cylinder, either through the port or opening between the valve 22 and its seat, or through the port or opening *i*, passage *k*, and port or opening *j* of the valve 17–18, or both of such ports or openings, until the pressure in each of the brake-cylinders equals that in its corresponding reservoir, or, in other words, until an equilibrium is established between the pressure in each brake-cylinder and its corresponding reservoir throughout the train.

From this description of the operation of defendants' quick-action triple valve it is manifest that the portion 18 of the valve 17–18 first opens communication between the chamber C and the brake-cylinder, and that such communication remains open until the pressure on the main air or train pipe side of the piston 29 is sufficiently greater than that upon the auxiliary reservoir side to force
53 the piston 29 forward a distance far enough to cause the port *i* to again enter the valve 22, and that the valve 22 is seated before such port or opening enters it.

The operation of said defendants' quick-action triple valve also makes it manifest that the valve 22 is supplemental or auxiliary to the main valve 17–18, and that such is the case no matter what one of the three classes of work heretofore referred to is performed.

This valve 22 is styled or termed a "main valve" in the description found in said Exhibit Defendants' 1891 Catalogue relating to the quick-action triple valve illustrated in plate XI of that catalogue, and in the description of the operation of said defendants' quick-action triple valve, it is stated as follows:

"TO APPLY THE BRAKES FULLY (*not a quick action*) an amount of air is allowed to escape gradually from the train-pipe that will move the piston 29 to unseat the main valve 22, and allow air to pass from the auxiliary reservoir through the same ports as when graduating, and in addition through that one opened by the main valve 22."

From this it would appear that in order "to apply the brakes fully (not a quick action)," which I understand to be making a "service" or other ordinary stop or, in other words, performing the second class of work to which I have heretofore referred, that it was necessary to unseat the valve 22, but I think it is manifest from what I have heretofore said, that such is not the fact, and in support of my view of this matter I find that it is stated on page 37 of said Exhibit Defendants' 1891 Catalogue that

"A service stop should be made with not more than two 'graduating' applications.

"The force with which the brakes will be applied in a service stop will be determined by the number of times the handle is placed in position 4, or the length of time it is allowed to remain there."

54 From a reading of all the matter relating to the operation of said defendants' quick-action triple valve found in said defendants' 1891 catalogue, I understand that the handle referred to in the above quotation is the handle of the engineer's operating valve or cock heretofore referred to, and which is styled on page 37

of defendants' 1891 catalogue "the engineer's brake-valve," and that the "position 4," referred to in the said quotation, is the position in which the handle of the engineer's operating cock or valve is placed when making a "graduating" application, and also the position in which the same handle is placed when making a "service stop."

From the above quotation I also understand that a "service stop" can be made in two ways; first, by a series of "graduating" applications, wherein the handle of the engineer's operating cock or valve is placed in "position 4," and allowed to stay there but a short time at each one of the series of applications used in making the "service stop;" and, second, by placing the handle of the engineer's operating valve or cock in the "position 4," and allowing it to remain there until the pressure in the main air or train pipe is reduced sufficiently to allow a sufficient amount of fluid pressure from the auxiliary reservoir to escape or expand into the brake-cylinders and stop the train. The "position 4," in which the handle of the engineer's operating cock or valve is placed, is a position where I understand fluid pressure is allowed to escape slowly or gradually, as distinguished from a position where it can escape suddenly, or the greatest amount in the shortest possible time is allowed to escape.

It is true that under certain conditions, which I will shortly describe, the valve 22 may be unseated and yet not have a direct admission of fluid pressure or air from the main air or train pipe to the brake-cylinder, or an admission which will cause quick action to take place, but whenever this takes place the action of such valve 22 is supplemental or auxiliary to that of the main valve
55 17–18, and it at no time can be correctly said to perform the main or primary functions in applying and releasing the brakes, and whatever its action may be, it is always auxiliary to the main valve 17–18.

The conditions to which I referred in the preceding paragraph, and under which the unseating of the auxiliary valve 22 might take place without the direct admission of fluid pressure or air from the main air or train pipe to the brake-cylinder taking place, or, if taking place, a quick action is not produced, are as follows: When the engineer allows fluid pressure to escape from the main air or train pipe at the engine slowly, so that the piston 29 is caused to move backward by preponderance of auxiliary reservoir pressure as heretofore explained, sufficiently to bring the port or opening *i* of the main valve 17–18 in communication with the chamber C, and when this is done auxiliary reservoir pressure cannot escape into the brake-cylinder faster than it can enter such chamber through the passage B, and as a result the pressure in the chamber C remains substantially that of the auxiliary reservoir, which is necessarily greater than that of the main air or train pipe, and therefore the check-valve 26 cannot be unseated because the main air or train pipe pressure is less than that in the chamber C, and when sufficient auxiliary pressure has entered the brake-cylinder to exert a pressure approaching that in the cylinders when a service stop is

made, then the engineer may allow any amount of pressure he chooses down to the entire amount in the main air or train pipe to escape therefrom and move the piston 29 to the extreme limit of its backward movement and unseat the valve 22 to its greatest extent, and the check-valve 26 will remain closed, because the pressure already in the brake-cylinder and chamber C would exceed the reduced pressure in the main air or train pipe and prevent the check-valve 26 from becoming unseated, and consequently the direct admission of main air or train pipe pressure past such valve into the brake-cylinder is prevented.

As before explained the fundamental or underlying prin-
56 ciple of what has become known as a quick-action system of brakes requires that the brake-cylinder should be comparatively free from pressure at or near the commencement of the admission of fluid pressure from the main air or train pipe to the brake-cylinders, and, under the conditions just named above, this fundamental or underlying principle is not present, and it is an impossibility under such a condition to have quick action take place.

Adjourned to meet at same place tomorrow, Friday, July 17th, 1891, at 10.30 o'clock a. m.

R. H. WHITTLESEY,
Special Examiner.

JULY 17, 1891.

Met pursuant to adjournment.
Present: Counsel as at last meeting.

The witness, HENRY F. NEWBURY, continues his answer to Int. 6:

(A. 6 continued.) Another condition under which the auxiliary valve 22 may be unseated and yet not have a direct admission of air or fluid pressure from the main air or train pipe to the brake-cylinder, is when the port or opening made by the unseating of such auxiliary valve and that of the port or opening *i*, combined together, are equal in capacity to the passage B, leading from the chamber C with the auxiliary reservoir portion of the piston chamber D, or when the capacity of such combined ports or openings does not exceed that of the passage B to an extent sufficient to reduce the pressure in the chamber C below that in the main air or train pipe, so that the spring 27 and the increased area of the check-valve 26 on its side adjacent to the chamber C will not permit such check-valve to be unseated by the main air or train pipe pressure acting upon the smaller area of such valve. Under this con-
57 dition there is no direct admission of pressure or air whatever from the main air or train pipe to the brake-cylinder, no matter whether there is any substantial pressure in the brake-cylinder or not from the beginning to the ending of the unseating of the auxiliary valve 22; and the only action of such valve is supplemental or auxiliary to that of the main valve 17–18, which performs the main or primary functions in applying and releasing the brakes.

Another condition under which, even though there be a direct admission of main air or train pipe pressure to the brake-cylinder, there can be no quick action or any substantial reduction of pressure in the main air or train pipe, is when the brake-cylinder has received pressure from the auxiliary reservoir to an extent sufficient to exert a pressure in both the cylinder and the chamber C, slightly less than will prevent the spring 27, and the greater area of the check-valve 26 on its side adjacent to the chamber C, from equalling the main air or train pipe pressure upon the opposite side of the check-valve, and by reason of the slightly greater force on the main air or train pipe side of the check-valve, such check-valve will open slightly and permit a slight escape of fluid pressure or air from the main air or train pipe adjacent to the check-valve, but not enough to in any way affect the next following quick-action triple valve, or to materially hasten or quicken the quick-action triple valve through which such slight escape takes place. Therefore, no quick action is possible, and the fundamental or underlying principle of such quick-action triple valves is not present, and any unseating of the auxiliary valve 22, even though it produces an admission of pressure directly from the main air or train pipe to the brake-cylinder as above described, is an action supplemental or auxiliary to the action of the main valve 17–18.

While it is, in my opinion, possible to so manipulate a single or even two or three quick-action triple valves, attached to as many cars, so that a slight direct admission of main air or train pipe pressure to the brake-cylinder upon the first car can take
58 place as just before described, yet I do not understand that this is the manner in which said Exhibit Defendants' Quick-action Triple Valve is intended to be manipulated or worked; for it is manifest that no useful function would be served, and for this reason alone I would be of the above understanding; but as a further reason of such understanding I will refer to the following statements found in said Exhibit Defendants' 1891 Catalogue, upon page 29:

"As the graduating valve" (main valve 17–18) "operates without moving the main valve," (auxiliary valve 22). "it produces a uniform action on the several cars of a train, thereby avoiding jerking and lurching in stopping the same.

"The actions of this valve in graduating, full service application, quick action, and the release, are the same as the new Westinghouse quick-action valve, thereby producing the same results in braking, which renders cars equipped with the two valves perfectly interchangeable, the hose coupling being the same."

The above quotation from said defendants' 1891 catalogue appears to settle beyond a doubt the manner in which "quick-action triple valves" like that of said defendants' quick-action triple valve are intended to work—that is, like "the new Westinghouse quick-action valve," which latter valve does not in practice, as I understand the matter, ever operate, or is intended to operate so that any direct admission of main air or train pipe pressure takes place into the brake-cylinder, although I believe it is possible to so manipulate it,

on a train of one or two cars, that an admission like that heretofor described as taking place under one of the conditions of use of sai defendants' quick-action triple valve will take place, yet if suc should be the case there could be no quick action, and fo
59 the reasons named when stating the condition of use abov referred to of said defendants' quick-action triple valve.

The auxiliary valve 22 is independent of the main valve 17–18 because the latter can be moved or operated to perform the mai or primary functions in applying or releasing the brakes withou moving or operating the auxiliary valve 22.

The main valve 17–18 controls or governs passages and ports in the casing or chest of said defendants' quick-action triple valve leading to connections with an auxiliary reservoir, a brake-cylinder and to the atmosphere respectively, as heretofore explained.

The auxiliary alve 22 controls or governs passages and ports leading to connections with a main air or train pipe and with the brake-cylinder respectively, and is actuated by the piston stem of the triple valve.

For convenience of tracing the above-named ports and passages and showing the direction of fluid pressure as it passes from the main air or train pipe to the auxiliary reservoir, brake-cylinder, and atmosphere, in the operation of said Exhibit Defendants' Quick-action Triple Valve, I will place upon said plate XI two series of arrows, one in full lines indicating the passages and ports and the direction which fluid pressure takes in passing from the main air or train pipe to the auxiliary reservoir, thence to the brake-cylinder, and from the brake-cylinder to the atmosphere; and the other or second series, in broken lines, indicating the passages and ports and direction which fluid pressure takes in passing from the main air or train pipe directly to the brake-cylinder.

I will also place upon Complainants' Exhibit Drawing Complainants' Quick-action Triple Valve and Connections and Complainants' Exhibit Drawing Defendants' Quick-action Triple Valve and Connections, the same letters, numerals and series of arrows which I have placed upon plate XI of said defendants' 1891 catalogue, or used in giving a description of the construction and operation of said Exhibit Defendants' Quick-action Triple Valve.

The piston 29 of the said Exhibit Defendants' Quick-
60 action Triple Valve has two movements or traverses—the first or preliminary movement or traverse operating the valve mechanism of said exhibit so as to admit fluid pressure or air from the main air or train pipe to the auxiliary reservoir, and then to admit pressure from the auxiliary reservoir to the brake-cylinder, to become operative in applying the brakes, and then to permit the escape or exhaust of such operative pressure, after its work is done, to release the brakes and thus perform the main or primary functions in applying and releasing the brakes.

The second or further movement or traverse of the piston 29, operates the valve mechanism of said "Exhibit Defendants' Quick-action Triple Valve," so as to open communication between the

main air or train pipe and the brake-cylinder, for the direct admission of fluid pressure or air from such pipe to the cylinder.

This second or further movement or traverse of the piston 29 of said "Exhibit Defendants' Quick-action Triple Valve," is greater in extent than that of the first or preliminary one, and the greater one includes the lesser.

The main valve 17–18 and auxiliary valve 22 of said Exhibit "Defendants' Quick-action Triple Valve," together form a valve mechanism actuated or controlled by the piston of the triple valve, and by means of which the two movements or traverses perform the three classes of work heretofore referred to by me.

The casing or chest, with its piston chamber D, piston 29, the main valve 17–18, and the passages and ports in such casing or chest, indicated by the series of arrows in full lines, form a "triple valve," having the three connections and threefold function heretofore referred to, by means of which the first two classes of work heretofore referred to are performed, as in the case of ordinary "triple valves."

Counsel for complainants offers and puts in evidence a catalogue entitled "Temporary Catalogue of Boyden Power Brake Company, Baltimore, Md., U. S. A., Automatic Quick-action
61 Brake System, 1889," and the same is marked "Complainants' Exhibit Defendants' 1889 Catalogue."

Defendants' counsel states that, through inadvertence, a slight error of fact has occurred in the stipulation entered at the beginning of this record, which counsel now desires to correct as follows: It is not true that prior to the time of the filing of the bill in this cause, the defendant corporation had made, used or sold quick-action triple valves, of which "Complainants' Exhibit Defendants' Quick-action Triple Valve" is a specimen, and which are shown and described in plate XI of Complainants' Exhibit Defendants' 1891 Catalogue and the descriptive matter relating thereto. On the contrary, the devices that were made, sold and used by the defendant corporation prior to the filing of the bill in this cause were the devices that are shown and described in Complainants' Exhibit Defendants' 1889 Catalogue, and more particularly illustrated in plate IX on page 22, and described on pages 23, 24 of said last-mentioned exhibit, said triple valves being used in connection with a main air or train pipe, auxiliary reservoirs and brake-cylinders, with the ordinary operative connections, substantially as indicated in the Exhibit Drawing Defendants' Quick-action Brake-valve and Connections. And it is only since the filing of the bill in this cause that the defendant corporation has made, used and sold the form of quick-action triple valve referred to in the stipulation made at the commencement of taking this testimony.

This correction is made, not for the purpose of raising any question as to the substantial similarity of the two forms of quick-action triple valve referred to in this statement of counsel, but for the purpose of putting the facts precisely as they existed. The error was overlooked until the production by the complainants of

62 their Exhibit Defendants' 1889 Catalogue called the defendants' attention to it.

To cure the technical defect in complainants' proofs, render the complainants' evidence pertinent to the issues, and give the court jurisdiction of the case, so that no detriment may result to complainants from the unintentional error hereinabove referred to, defendants' counsel consents that the court may consider the case in all respects as if it had been true in fact that, prior to the filing of the bill in this cause, the defendant corporation had actually made, sold and used one or more of the quick-action triple valves referred to in the opening stipulation; and to that end, and for all purposes of this cause, defendants' counsel, as a matter of form, admits that prior to the filing of this bill the defendant corporation made, sold and used two of said quick-action triple valves, and that said two valves were used in such a way as to give full effect to the principles of action intended to be brought into operation by means of them, that is to say, in connection with a main air or train pipe, auxiliary reservoirs and brake-cylinders, with the ordinary operative connections, substantially as indicated in the Exhibit Drawing Defendants' Quick-action Triple Valve and Connections.

It is stipulated that said Exhibit Defendants' 1889 Catalogue is a catalogue issued and circulated by the defendant corporation subsequent to the date of the patents sued on, and prior to the filing of the bill in this cause.

(Here follows diagram marked p. 62*a*.)

Int. 7. Please examine plate IX and the accompanying description in defendants' 1889 catalogue, and state in what manner and to what extent the construction and operation of the "quick-action brake-valve" therein set forth accord with or differ from those of the quick-action triple valve of defendants' 1891 catalogue as described by you in your answer to Int. 6.

63 A. I have carefully examined said plate IX of said defendants' 1889 catalogue, and the descriptive matter relating thereto, and I find that the "quick-action brake-valve" shown in such plate IX, and described in the said descriptive matter, is in all essential respects substantially the same as the "quick-action triple valve" shown in plate XI, and described in the descriptive matter relating thereto in said defendants' 1891 catalogue.

There is some difference in the form and arrangement of the passages in the casing or chest of the "quick-action brake-valve" of said defendants' 1889 catalogue and the "quick-action triple valve" of plate XI of said defendants' 1891 catalogue.

For convenience in the comparison called for by the question, I will term the quick-action brake-valve of said defendants' 1889 catalogue, defendants' 1889 quick-action brake-valve, and the quick-action triple valve of said defendants' 1891 catalogue, defendants' 1891 quick-action triple valve.

There is a difference in the form and construction of the main valve 17, 18 and the auxiliary valve 22 of said defendants' 1891

BLEED THROUGH POOR COPY

"quick-action triple valve" and the corresponding main and auxiliary valves of said defendants' 1889 "quick-action brake-valve," that is, in the former the main valve 17–18 is of the sliding type, and the auxiliary valve 22 is of the poppet type, while in the latter the corresponding main valve 14–29 is of the poppet type, and the corresponding auxiliary valve 41 is of the sliding type. These differences in the type of the two valves of said defendants' 1891 "quick-action triple valve" and said defendants' 1889 "quick-action brake-valve," necessitate some changes in the construction of the valves and the arrangement of the passages in the casing or chest, but the operation of said 1891 "quick-action triple valve," and said 1889 "quick-action brake-valve" are substantially the same, and they perform substantially the same work, with substantially the same means, and in substantially the same way. Therefore
64 they are in substantial accord with one another, and do not materially differ, for the purposes of the present comparison.

One difference in the construction of the main valve *valve* 17–18 of said defendants' 1891 "quick-action triple valve," and the corresponding main valve of the said defendants' 1889 "quick-action brake-valve," rendered necessary by the difference in type of those two valves heretofore referred to, is that said main valve of the latter is divided into two parts so that they can be separated from each other under certain conditions during a portion of their operation; but, as before stated, this difference is not a material one.

For convenience of tracing the passages and ports and the direction which fluid pressure takes in passing from the main air or train pipe to the auxiliary reservoir, and thence to the brake-cylinder, where it is operative in applying the brakes, and from which it escapes or exhausts to the atmosphere to release the brakes and the passages and ports and the direction of fluid pressure from the main air or train pipe directly to the brake-cylinder, I will place upon plate IX of said Exhibit Defendants' 1889 Catalogue the same letters, characters, and series of arrows which I used or placed upon plate XI of said Exhibit Defendants' 1891 Catalogue.

I will hereafter produce a drawing on an enlarged *seal*, similar to the one marked "Complainants' Exhibit Drawing Defendants' Quick-action Triple Valve and Connections" except that the form and construction of the said defendants' 1889 "quick-action brake-valve" will be substituted in place of said defendants' 1891 "quick-action triple valve," in order to show the connection of said defendants' 1889 "quick-action brake-valve" with the main air or train pipe, auxiliary reservoir, brake-cylinder and atmosphere. And I will place thereon corresponding designating letters, numerals and series of arrows found on said "Complainants' Exhibit Drawing Defendants' Quick action Triple Valve and Connections."

Int. 8. Will you please compare "Complainants' Exhibit
65 Defendants' Quick-action Triple Valve" with the mechanism or devices described and shown in "Complainants' Exhibit Patent 360,070," and particularly pointed out in claims 1, 2 and 4 thereof, and state the resemblances and differences, which you find

but I did not deem this difference a material one when considering the substantial identity between the two auxiliary valve devices. For, as I understand the matter, the prime object of the auxiliary valve in each case is that it shall control or govern passages and ports leading from the main air or train pipe to the brake-cylinder, so that such auxiliary valve device can open communication for the direct admission of fluid pressure or air from the main air or train pipe to the brake-cylinder, and thereby cause a reduction in the pressure in such pipe at a point adjacent to such triple valve, so as to affect the following or next adjacent triple valve, and thereby cause a still further reduction of the pressure in such main air or train pipe to quicken the operation of such following or next adjacent triple valve, and so on throughout the length of the train supplied with such quick-action triple valves. And also that the fluid pressure or air escaping from such main air or train pipe at the several quick-action triple valves is utilized in the brake-cylinders to apply the brakes with greater force than is done when no direct admission of fluid pressure or air takes place from the main air or train pipe to the brake-cylinders; and, in the case of defendant's quick-action triple valve, the above-named prime object is served in substantially the same way and by substantially
69 the same means as it is served in the preferred or illustrated form of the patent No. 360,070 in suit.

I also took into consideration the fact that the check-valve 26 of said defendant's quick-action triple valve performs the function that is performed by the feeding groove or opening 51 of the preferred or illustrated form of said patent No. 360,070 in suit, as well as the function performed by the check-valve 49 of such preferred or illustrated form of said patent in suit; but I did not deem this difference a material one, because, as I understand the matter, it was old in the art to have a check-valve, opened by main air or train pipe pressure and closed by auxiliary reservoir pressure to serve the purpose of the feeding groove or opening 51 in the piston chamber 11, and that such a check-valve was one of the means employed for charging the auxiliary reservoir with fluid pressure from the main air or train pipe, prior to the date of the patent No. 360,070 in suit, and comes within the statement heretofore quoted, relating to what is meant by the terms "triple valve" and "triple-valve device."

The function of a check-valve, which permits main air or train pipe pressure upon one side of it to open it when such pressure exerts a force greater than that exerted on its other or opposite side, and is closed when such main air or train pipe pressure exerts a less force than is exerted upon its other side, is the same, and its mode of operation is the same, when used for admitting main air or train pipe pressure to the auxiliary reservoir, or admitting such pressure directly to the brake-cylinder.

Furthermore, I do not understand that the combination of devices particularly pointed out in claim 1 of the patent in suit necessarily requires that there shall be any part or device which shall serve the function of the check-valve 49 in the preferred or illustrated form in which such check-valve forms a part, and therefore the only re-

quirement, as I understand it, of the combination of devices particularly pointed out in said claim 1 is that the "triple valve" of that claim shall have some kind of device by means of which
70 main air or train pipe pressure is permitted to enter the auxiliary reservoir or pass by or through the piston of such triple valve. And because of all the above facts and understandings I am clearly of the opinion that the fact that the check-valve 26 in said "defendants' quick-action triple valve" serves a twofold function as above stated, is a wholly immaterial one, when considering the substantial identity between the combination of devices particularly pointed out in the said claim 1 of the patent No. 360,070 in suit, and said "defendants' quick-action triple valve."

I also took into consideration the fact that the piston of the triple valve of the said "defendants' quick-action triple valve" is arranged relatively to the auxiliary valve 22 of that device, so that a portion of the main valve 17–18 moves in such auxiliary valve, while such is not the case in the preferred or illustrated form of the patent No. 360,070 in suit. But I did not deem this difference a material one, when considering the substantial identity between the combination of devices particularly pointed out in claim 1 of the said patent in suit and the said "defendants' quick-action triple valve," for in each case the arrangement of piston, main valve, and auxiliary valve is such that the auxiliary valve is actuated by the piston, and is independent of the main valve in performing the main or primary functions of applying and releasing the brakes, and also that when such auxiliary valve is actuated by the piston it has the capacity for admitting main air or train pipe pressure directly to the brake-cylinder in the application of the brakes in quicker or shorter time and with greater force than in making "service" stops, and this is, as I understand the matter, the essential thing, and the special form or arrangement of the parts is wholly immaterial. And because of this I am clearly of the opinion heretofore stated regarding the present difference.

Adjourned until Saturday, July 18, at 10.30 a. m.

71 July 18, 1891.

Met pursuant to adjournment.
Present: Counsel as before.

The witness, Henry F. Newbury, continues his answer to Int. 8.

(Answer continued.) As to the materiality of the differences pointed out between said defendants' quick-action triple valve and the preferred or illustrated form of the combination of devices particularly pointed out in claim 1 of said patent 360,070, I took into consideration the following facts, in addition to those heretofore stated, viz:

That the patentee Westinghouse was, so far as I can learn from the prior state of the art, referred to in the answer herein or elsewhere, the first to devise an automatic system of fluid-pressure brakes, in which the action of one triple valve in any way affected

or quickened the action of another triple valve of the system in which the first one was placed; also that he was the first to devise a system of fluid-pressure brakes in which the action of one triple valve reduced the pressure in a main air or train pipe, and thereby aided in the operation of the next or following triple valve; also, that he was the first to devise a system in which main air or train pipe pressure——

Defendants' counsel, observing that witness is reading his answer this morning from written memoranda or notes, objects thereto. Counsel did not object to his reading from notes during the early part of the session this week when he was explaining the construction and operation of complainants' device and patent, but thinks it not proper to pursue the practice when testifying as to the defendants' structure and the question of infringement.

Counsel for the complainants submits to the court that there is no impropriety in the witness using notes or memoranda which
72 he is prepared to submit, if necessary, in order to expedite the taking of a lengthy deposition. Maintaining the right of the witness so to do, counsel suggests that, to avoid any question in the matter, the witness hereafter abstain from using his notes, devoting whatever additional time may be rendered necessary by such course.

The witness states that he will recommence his answer at the point at which he had begun to use his notes.

Answer so continued.

As to the materiality of the differences between said defendants' quick-action triple valve and the preferred or illustrated form of the combination of devices particularly pointed out in said claim 1, just referred to in connection with the comparison between said defendants' quick-action triple valve and said combination of devices, I took into consideration the following facts, viz:

That the patentee Westinghouse, so far as I can learn from the prior state of the art referred to in the answer in this cause or elsewhere, was the first to devise an automatic system of brakes in which the action of one triple valve in any way affected or quickened the operation of the next triple valve in the system.

Also that he was the first to devise an automatic system of brakes in which the action of one triple valve reduced the fluid pressure or air in the main air or train pipe, and thereby aided in the operation of the next or following triple valve placed in the system.

Also that he was the first to devise an automatic system in which there were means provided for a direct admission of main air or train pipe pressure to the brake-cylinder, when such cylinder was substantially free from pressure, as upon the beginning of the application of the brakes to the wheels of the cars.

Also that he was the first to devise an automatic system in which there was an auxiliary valve or valve device, which was
73 actuated by the piston of the triple valve, by means of which main air or train pipe pressure was admitted directly to the brake-cylinder, to be utilized therein, and which direct admission

of fluid pressure from such main air or train pipe reduced the pressure in such pipe, and by reason of such reduction affected and quickened the action of the next or following triple valve.

Also that he was the first to devise an automatic system in which fluid pressure or air in the main air or train pipe of lower pressure or force than that in the auxiliary reservoir was admitted to the brake-cylinder from such pipe to be utilized in such cylinder, and be supplemented or added to by the higher pressure or air in the auxiliary reservoir to apply the brakes with an increased force to the wheels of the train.

Also that he was the first to devise an automatic system in which there was a "triple valve" and a valve mechanism which had two movements or traverses; the first or preliminary movement or traverse of such piston and valve mechanism admitted pressure or air from the auxiliary reservoir alone to the brake-cylinder, and the second or further movement or traverse of which admitted fluid pressure or air from the main air or train pipe directly to the brake-cylinder, as well as from the auxiliary reservoir.

The above facts, I think, make it entirely manifest that the said patentee, George Westinghouse, Jr., was the first to devise an automatic quick-action system of brakes, and that in view of the above facts any minor arrangements of parts or change in the form which they *make* take, such as the differences named in the above comparison between said defendants' quick-action triple valve and the combination of devices particularly pointed out in said claim 1, which does not affect or change the substantial operation of the structures as a whole, is wholly immaterial when considering such substantial identity.

Because of all the facts heretofore stated I am clearly of the opinion that the said "defendants' quick-action triple valve,"
74 when the same is connected to a main air or train pipe, auxiliary reservoir and brake-cylinder, as shown in said "Exhibit Drawing of Defendants' Quick-action Triple Valve and Connections," resembles the combination of devices particularly pointed out in claim 1 of the said patent 360,070 in all essential particulars, and that any differences which may exist in the form or arrangement of the several parts of the two are wholly immaterial.

I have also made the comparison called for by the question, between the said "defendants' quick-action triple valve" when the same is connected to a main air or train pipe, auxiliary reservoir, and brake-cylinder as shown in said "Exhibit Drawing of Defendants' Quick-action Triple Valve and Connections," and the combination of devices particularly pointed out in claim 2 of said patent 360,070, and find that they resemble each other in having the following four essential elements or devices, combined together to form a brake mechanism for use in what is known as the "automatic quick-action" system of brakes:

a. There is in each a main air or train pipe, adapted to connect with a source of fluid pressure or air supply, and a "triple valve."

b. There is in each a reservoir, adapted to be connected with the source of fluid pressure or air supply through a "triple valve," and

BLEED THROUGH POOR COPY

also adapted to be attached to a car and be auxiliary to the main reservoir upon the engine, and is known as an auxiliary reservoir.

c. In each there is a brake-cylinder, provided with a piston and means for connecting the same with the brake-shoes of the wheels of the car, so that such brake-shoes may be applied to the wheels and released therefrom by the movement of the piston actuating the shoes in one direction and other well-known means actuating the said shoes in the opposite direction.

75 The above three devices or elements are substantially the first three of the combination of claim 1 of said patent 360,070.

d. In each there is a "triple valve," provided with a piston and a valve mechanism, the piston having two movements or traverses, one greater in extent than the other, the greater one including the lesser—the first or preliminary movement or traverse of such piston operating the valve mechanism for the admission of fluid pressure or air from the auxiliary reservoir to the brake-cylinder to perform the functions of an ordinary "triple valve" in the first two classes of work heretofore referred to, and the second or further movement or traverse of such piston operating the valve mechanism so as to open communication between the main air or train pipe and the brake-cylinder for the direct admission of fluid pressure or air from such pipe to such cylinder to perform the third class of work heretofore referred to.

In each the above four essential elements or devices I find to be combined together in substantially the same way, to perform substantially the same work, by substantially the same means, and in substantially the same manner.

In forming the above opinion as to the substantial identity between said defendants' quick-action triple valve, when connected as stated, and the combination of devices particularly pointed out in said claim 2 of patent 360,070, I took into consideration the several differences to which I referred when considering a similar question regarding the combination of devices of said claim 1, as well as the several facts bearing upon the materiality of such differences, and I do not think it necessary to again repeat them.

I am clearly of the opinion that the said "defendants' quick-action triple valve," when connected to a main air and train pipe, auxiliary reservoir and brake-cylinder, as illustrated in said "Exhibit Drawing of Defendants' Quick-action Triple Valve and Connec-
76 tions," is substantially identical with the combination of devices particularly pointed out in said claim 2 of patent 360,070, in all essential particulars, and that what differences in mere form there may exist are wholly immaterial when considering the substantial identity between said "quick-action triple valve," when connected as stated, and said combination of devices as particularly pointed out in said claim 2.

I have also made the comparison required by the question regarding the combination of devices particularly pointed out in claim 4 of said patent 360,070, and find that the said "defendants' quick-action triple valve," and the combination of devices particu-

larly pointed out in said claim 4 of said patent 360,070, resemble each other in having the following four essential elements or devices combined together in a single casing or chest to form what is known as a "quick-action triple valve," viz:

a. In each there is a casing or chest, provided with a chamber adapted to receive a piston, and have the same work therein; and also provided with ports and passages adapted to connect with an auxiliary reservoir, a brake-cylinder and the atmosphere, and also provided with passages leading to connections adapted to connect with a main air or train pipe and the brake-cylinder.

b. In each there is a piston fixed upon a stem, and adapted to work in a chamber in the casing or chest, and also to actuate an auxiliary valve or valve device.

c. In each there is a valve adapted to be moved by the piston, and to govern or control the ports or passages in the casing or chest leading to the connections with an auxiliary reservoir, a brake-cylinder and the atmosphere.

d. In each there is an auxiliary valve adapted to control or govern communication between the passages in the casing or chest leading to the connections with a main air or train pipe and a brake-cylinder.

77 In each, the above four essential elements I find to be combined together in substantially the same way, to perform substantially the same work, in substantially the same manner, and by substantially the same means.

In forming the above opinion, as to the substantial identity between said "defendants' quick-action triple valve," and the combination of devices particularly pointed out in said claim 4, I took into consideration the several differences to which I referred when considering a similar question regarding the combinations of devices of claims 1 and 2 of said patent 360,070, as well as the several facts bearing upon the materiality of such differences, and I will not repeat them.

I am clearly of the opinion that the said "defendants' quick-action triple valve" is substantially identical with the combination of devices particularly pointed out in said claim 4 of patent 360,070 in all essential particulars, and that what differences in mere form there may exist are wholly immaterial, when considering the substantial identity between said "quick-action triple valve" and said combination of devices as particularly pointed out in claim 4.

Int. 9. To what extent are the opinions expressed in your answer to interrogatory 8 as to "defendants' quick-action triple valve" applicable to and applied by you to the "quick-action brake-valve" of plate IX of defendants' 1889 catalogue, when connected to a main air or train pipe, auxiliary reservoir and brake-cylinder, substantially as illustrated in "Complainants' Exhibit Drawing Defendants' 1889 Quick-action Brake-valve and Connections?"

A. The said "Complainants' Exhibit Drawing Defendants' 1889 Quick-action Brake-valve and Connections" I understand to be the drawing which I stated in my answer to interrogatory 7, I would hereafter produce, and which, it will be remembered, was to be the

same as "Complainants' Exhibit Drawing Defendants' Quick-action Triple Valve and Connections," excepting that defend-
78 ants' 1889 "quick-action brake-valve" was to be put in place of said defendants' 1891 "quick-action triple valve."

As I have heretofore stated, there is no substantial difference between the said defendants' 1889 "quick-action brake-valve" and said defendants' 1891 "quick-action triple valve," and therefore it follows that whatever I have said in my answer to Int. 8, or the opinions which I therein expressed regarding the substantial identity between said defendants' 1891 "quick-action triple valve" and the combinations of devices particularly pointed out in claims 1, 2 and 4 of said patent 360,070 apply with equal force and to the same extent when considering the substantial identity between said defendants' 1889 "quick-action brake-valve" and the combinations of devices particularly pointed out in claims 1, 2 and 4 of said patent 360,070.

Whatever differences there may exist between the said defendants' 1889 "quick-action brake-valve" and said defendants' 1891 "quick-action triple valve," to which I have heretofore referred, are differences which, in my opinion, are wholly immaterial, and would not in any way affect the substantial identity between said defendants' 1889 "quick-action brake-valve" and the several combinations of devices particularly pointed out in claims 1, 2 and 4 of patent 360,070, any more than the several differences pointed out between said defendants' 1891 "quick-action triple valve" and the same several combinations of devices; and my reasons are substantially the same for this opinion as those given in my answer to said Int. 8.

Int. 10. Will you please produce and briefly explain an illustration showing a quick-action triple valve of the construction set forth in patent 360,070, located in operative position in an automatic air-brake apparatus?

A. I do produce an illustration as requested in the question and will briefly explain the same.

The said illustration represents those portions of an automatic air-brake apparatus which are located upon the locomotive or engine, the engine tender and one passenger car, and I will
79 separate the parts of the said apparatus located upon the engine, tender and passenger car, by marking the couplings in the main air or train pipe which separate to disconnect or uncouple the engine from the tender and the tender from the passenger car.

All of the several parts are in section, except the flexible hose, couplings and angle cocks, which connect the rigid portions of the main air or train pipe, and the pressure gauge and some of the connections located upon the engine. The coupling between the engine and tender I will mark A. The one between the tender and the passenger car, B, and the one leading from the passenger car to the next following car, C. The air-compressing engine or pump, which is located upon the engine, I will designate "air pump." The ordinary or plain triple valve located upon the tender of the engine I will designate "ordinary triple valve," and the quick-ac-

tion triple valve located upon the passenger car, "quick-action triple valve."

I will also mark the main air or train pipe "main air or train pipe."

The other portions of the said illustration are already marked or designated.

The "air pump," by means of which air is compressed, is suitably connected with the boiler of the engine or locomotive so as to receive steam therefrom and be operated. A governor is placed in such connection between the boiler and the air pump, by means of which the compressed air or fluid pressure in the main reservoir located upon the locomotive or engine regulates or governs the supply of steam to the air pump, so that such air pump is automatically stopped and started, or in a measure controlled, by the amount of fluid pressure which the air pump has forced into the main reservoir.

The operating cock or engineer's valve, by means of which the fluid pressure or compressed air in the main air or train pipe is varied to operate either the ordinary "triple valve" or the "quick-action triple valve" is arranged so as to be under the control of the engineer as occasion may require, either to admit compressed
80 air or fluid pressure from the main reservoir to the main air or train pipe, to increase the pressure therein and move the pistons of the "triple valves" in the forward direction, or permit main air or train pipe pressure to escape from such pipe and reduce the pressure therein, and move the pistons of the "triple valves" in their backward direction.

The pistons of both the ordinary "triple valve" and the "quick-action triple valve" are shown in the illustration at the extreme limit of their forward movement or stroke, as they would be when the train was in "running order," that is with the main air or train pipe and auxiliary reservoirs charged with fluid pressure or compressed air to the desired extent, such pressure being substantially equal throughout the train. The pistons of the brake-cylinders are shown in the position which they occupy when the brake-cylinders are free from pressure, or the pressure in them is that of the atmosphere, springs being used to return and hold them in such position upon the escape of fluid pressure from the brake-cylinders to the atmosphere.

The connections between the pistons of the brake-cylinders and the brake-shoes are not shown in said illustration, but are left to be supplied, of any well-known or convenient form.

The automatic control of the air pump, as before described, keeps the main reservoir upon the locomotive or engine supplied with the desired amount of fluid pressure, which is generally somewhat higher than that employed in the main air or train pipe, so that there can be an escape therefrom to the main air or train pipe up to the desired limit of pressure in such pipe, as it will be remembered that the escape of fluid pressure or compressed air from the main reservoir necessarily reduces the pressure therein in proportion to the escape therefrom; and if the pressure in the main reser-

voir did not exceed the desired limit of pressure in the main air or train pipe there could be no escape of fluid pressure from
81 said main reservoir such as would increase the fluid pressure or compressed air in the main air or train pipe to the desired limit.

On the engineer's desiring to apply the brakes he would turn the handle of the engineer's cock or valve, so as to allow sufficient fluid pressure or air to escape from the main air or train pipe at the point of such cock or valve marked "Exhaust," to reduce the main air or train pipe pressure from two to five pounds, then closing his cock or valve, preventing further escape of main air or train pipe pressure, and the pistons of the several "triple valves," owing to the reduction of the main air or train pipe pressure to the extent named, would be moved backward sufficiently to cause the main valves of such "triple valves" to first close communication between the several brake-cylinders and the atmosphere, and then to open communication between the several auxiliary reservoirs and brake-cylinders, whereupon fluid pressure or air from such reservoirs would escape or expand into such cylinders, and such escape or expansion would reduce the pressure in such reservoirs slightly below the main air or train pipe pressure, which would result in the said triple-valve pistons moving in a forward direction, owing to the preponderance of pressure upon the main air or train pipe side of such pistons. This forward movement of the triple valve pistons would cease when such movement had caused their main valves to close communication between the several auxiliary reservoirs and brake-cylinders, because there would be no further reduction of auxiliary reservoir pressure upon the closure of communication between them as stated, and therefore the triple-valve pistons would necessarily come to a state of rest owing to the equilibrium of pressure upon their two sides, and whatever fluid pressure had expanded or escaped into the several brake-cylinders from their several auxiliary reservoirs would be held and be operative therein in applying the brakes. The above operation is known as a "graduating" application, and if the pressure in the brake-cylinders does not sufficiently reduce the
82 speed of the train or hold it in check upon a downgrade, the engineer allows another slight reduction in pressure equal to or less than the first one, as his judgment may dictate, whereupon the main air or train pipe pressure is reduced below that in the auxiliary reservoirs, and the pistons of the several triple valves move backward again sufficiently to again open communication between the auxiliary reservoirs and the brake-cylinders, whereupon another escape or expansion of auxiliary reservoir pressure takes place into the brake-cylinders, augmenting the force already there and increasing the force with which the brake-cylinder pistons cause the brakes to be applied to the wheels of the train. This second escape or expansion of fluid pressure or air from the auxiliary reservoirs to the brake-cylinders causes a second reduction in auxiliary reservoir pressure sufficient to cause the several triple-valve pistons again to move in a forward direction sufficiently to close communication between the auxiliary reservoirs and the brake-

cylinders. And as many of these "graduating" applications would be made as the judgment of the engineer dictated and the circumstances of the particular case required.

When the engineer desires to release the brakes of the train, he turns the handle of his operating valve or cock to the point where its ports and passages open communication between the main reservoir on the engine and the main air or train pipe, permitting sufficient compressed air or fluid pressure to escape therefrom into said pipe so as to increase said main air or train pipe pressure to the desired limit. Whereupon he closes said cock or valve, and the increased main air or train pipe pressure causes the several triple-valve pistons to move forward to their extreme limit of movement in that direction, which results in again opening communication between the several brake-cylinders and the atmosphere, and consequently the escape or expansion of the fluid pressure which had been operative in the brake-cylinders permits the coiled springs to again return the pistons of the brake-cylinders to the position shown in said illustration, and to release the brakes from the wheels
83 of the train and at the same time to permit the auxiliary reservoirs to be recharged with fluid pressure or air to the desired limit.

The above operation is known as "graduating," and is the first class of work to which I have heretofore referred.

As before stated, "service" stops, or the second class of work to which I have heretofore referred, can be made or performed by a series of two or more "graduating applications." Or such second class of work or "service stops" can be performed or made by the engineer turning his handle so as to cause a slow and steady escape of main air or train pipe pressure to take place through his operating cock or valve, and in this way cause the several triple-valve pistons to move backward and first close communication between the several brake-cylinders and the atmosphere, and then open communication between the several auxiliary reservoirs and the brake-cylinders. This slow and steady reduction of main air or train pipe pressure should substantially agree with the reduction of auxiliary reservoir pressure by its escape or expansion into the brake-cylinders so as to hold the several triple-valve pistons in position to keep communication open between the several auxiliary reservoirs and their brake-cylinders until the pressure therein has been equalized, that is, until a substantial equilibrium between the pressure of each auxiliary reservoir and its brake-cylinder is established, when the escape of main air or train pipe pressure should cease, for any further escape would be simply a waste and could serve no useful purpose.

With the desired limit of main air or train pipe pressure placed at seventy pounds, a reduction of such pressure to the extent of about twenty pounds will cause the triple-valve pistons to operate as just stated in making a "service" stop or performing the second class of work heretofore referred to, and the equalized pressure of the auxiliary reservoirs and their brake-cylinders would be about

fifty pounds to the square inch, and any reduction in main
84 air or train pipe pressure below that point would of course be
useless and a waste.

To release the brakes the engineer would increase the main air or train pipe pressure to the desired limit, the same as when the first class of work or "graduating" was performed, and with like results.

In case a collision or other accident is to be avoided, and the train stopped in the shortest space of time, regardless of all other considerations, the engineer turns the handle of his operating cock or valve so that a sudden and considerable reduction of main air or train pipe pressure takes place in the train-pipe adjacent to the point of its escape, as, say, a reduction of twenty pounds, whereupon the piston of the first quick-action triple valve, as the one on the passenger car as shown in this illustration, is caused to quickly move to the extreme limit in its backward direction, thereby contacting or connecting with some portion of an auxiliary valve or valve device, or moving some portion of its valve mechanism to such an extent that communication is opened directly between the main air or train pipe before the main valve or valve mechanism operated or actuated by the triple-valve piston permits any substantial escape or expansion of auxiliary reservoir pressure into the brake-cylinders, to interfere with the admission of main air or train pipe pressure from such pipe directly into the brake-cylinders, which direct admission of main air or train pipe pressure causes a reduction of such pressure in such pipe adjacent to the first "quick-action triple valve," which reduction causes the next adjacent or succeeding "quick-action triple valve" to in like manner operate, and so on throughout the train supplied with "quick-action triple valves." This series of reductions in pressure in the main air or train pipe takes place without the fluid pressure or air traveling from the rear end of the train to a single opening at the engine, there being as many openings as there are "quick-action triple valves" in the train.

The direct admission of main air or train pipe pressure to
85 the brake-cylinders causes the pistons in such cylinders to
apply the brakes with a greater force than is done in making a "service" stop, and with the train-pipe pressure of seventy pounds to the square inch, the equalized pressures in the auxiliary reservoirs and brake cylinders is in the vicinity of sixty pounds to the square inch in such brake-cylinders as receive such direct admission of main air or train pipe pressure, and the main air or train pipe pressure will be reduced to about forty pounds.

This operation is known as "quick action," and "triple valves" having the capacity of operating as just stated are known as "quick-action triple valves," and perform the third class of work heretofore referred to.

To release the brakes, when a "quick action" or "emergency stop" has been made, as just described, the engineer turns the handle of his operating valve or cock so as to open communication between the main reservoir and the main air or train pipe, and in-

crease the pressure in such pipe up to the desired limit, when the several triple-valve pistons will move forward to the extreme limit of their movement in that direction, as in the case of "graduating" or making "service stops," and in like manner release the brakes and recharge the auxiliary reservoirs.

It is customary for each passenger car to be supplied with a valve or cock known as a "conductor's valve," the handle of which valve can be operated by a cord extending throughout the length of the car, so that the conductor or another person can, by pulling upon said cord, operate said conductor's valve and open communication between the main air or train pipe and the atmosphere and cause a reduction in main air or train pipe pressure, which will operate the triple-valve piston of the "quick action triple valve" nearest the conductor's valve so opened, to operate as just described, which would in turn operate the next adjacent or succeeding "quick-action triple valve" in a manner similar to that just described. Such conductor's valve is so designated upon the said illustration.

If upon the breaking in two of the train, or any accident
86 happening to the main air or train pipe, or its connections
with the several "triple valves," or "conductor's valves," by means of which the main air or train pipe pressure is allowed to escape and become reduced, the "quick-action triple valves" nearest to such point of escape, no matter in what portion of the train it might take place, would operate as the first "quick-action triple valve" operated when the engineer permitted a sudden and considerable reduction of main air or train pipe pressure to take place at the engine, and the "quick-action triple valve" which operated first in either portion of the train would also cause the next adjacent or succeeding "quick-action triple valve" to operate as before described, and this would continue until all the triple valves throughout the entire train had operated, and applied the brakes in the shortest possible time and with the greatest available force.

One of the advantages of such "quick-action triple valves" is that their operation does not in any way impede the operation of the ordinary "triple valves," and also that the ordinary "triple valves" do not otherwise impede the operation of "quick-action triple valves," except that they lengthen the distance between the point of sudden reduction of main air and train pipe pressure and the point where the "quick-action triple valve" is located, and because of this fact cars equipped with the ordinary "triple valve" can be used in a train with cars equipped with "quick-action triple valves," and yet have the two kinds of "triple valves" operative for performing the first two classes of work heretofore referred to, and also have the quick action triple valves operative in an emergency to an extent at least proportionate to the number of such quick-action triple valves which are scattered through the train.

The air, before compression, contains more or less moisture, and therefore it is necessary to provide means for relieving the main air or train pipe, as well as other portions of the devices, where they do
not readily drain into such pipe, of the water or fluid collect-
87 ing therein from such moisture. Two such devices are shown

in the said illustration, one of them being upon the passenger car and the other upon the tender, that upon the tender being designated "drip-cup" and the other "car drain-cup."

The illustration referred to by the witness is here put in evidence by counsel for complainant-, and is marked "Complainants' Illustration Automatic Brake System."

Counsel for complainants here states upon the record that complainants will not ask for a decree upon the patent No. 168,359, nor upon the fifth claim of patent No. 360,070.

Adjourned to Wednesday, July 22, 1891, at 10.30 a. m., at the same place.

NEW YORK, *July* 22, 1891.

Met pursuant to adjournment.

Counsel present as at last meeting.

The witness produces the drawing referred to by him in the closing paragraph of his answer to Int. 8, and states that the same is on an enlarged scale and similar to "Complainants' Exhibit Drawing Defendants' Quick-action Triple Valve and Connections," except that the form and construction of defendants' 1889 "quick-action brake-valve," as illustrated in defendants' 1889 catalogue, are substituted in place of defendants' 1891 "quick-action triple valve," and states that said drawing correctly represents the connection of defendants' 1889 "quick-action brake-valve," with a main air or train pipe, auxiliary reservoir, brake-cylinder, and the atmosphere, as said "quick-action brake-valve" is employed in practice in an automatic quick-action brake apparatus.

88 The drawing referred to is offered and put in evidence by counsel for complainants and is marked:

"Complainants' Exhibit Drawing Defendants' 1889 Quick-action Brake-valve and Connections," R. H. Whittlesey, special ex'r.

Cross-examination by LYSANDER HILL, Esq., of counsel for defendants:

X Int. 11. In your examination-in-chief you have intimated your opinion that the 1st, 2d and 4th claims of the patent in suit are to be broadly construed, for the reason that, as you assume, Mr. Westinghouse was the first in the art to invent a quick-action triple-valve mechanism for air brakes. Inasmuch as this involves a question of law, and your opinion as to the scope of the claims in suit seems to be based in whole or in part on your understanding of such law, I desire to know what that understanding is. I therefore ask you whether it is your understanding that Mr. Westinghouse, if he was in fact the first in the art to invent a quick-action triple-valve mechanism, became thereby entitled in law to claim the quick-action result or effect, however produced, or, on the other hand, became entitled to claim only the mechanical devices and combinations of devices by which he enabled his triple valve to accomplish such result or effect?

A. As I understand the question, it does not commence with a

correct statement of my position, and in order that there may be no doubt on this point, I will briefly state it:

The fact that Mr. Westinghouse was the first to devise an automatic system of brakes in which the operation of one triple valve affected and quickened the operation of the next adjacent triple valve, and, in so doing, reduced the main air or train pipe pressure, so as to produce a like effect upon the next or adjoining triple valve, and thereby made what has become to be known as "quick action" in automatic brakes possible, by simply varying the manner
89 in which the fluid pressure or air in the main or train pipe was controlled by the engineer upon the locomotive, had to do with the materiality of the several differences which I pointed out between said "defendants' quick-action triple valve," and the preferred form which the combination of devices particularly pointed out in claims 1, 2 and 4, were illustrated in the drawing of the said patent 360,070, and was not the only reason why such differences were immaterial when considering the substantial identity of the said defendants' quick-action triple valve, and the combination of devices particularly pointed out in said claims 1, 2 and 4, as clearly appears from what I have heretofore said.

In this connection it will be observed that in those portions of the specification which I have heretofore quoted regarding the object of the invention of said patent 360,070, and what it consists of when generally stated, which is as follows:

"The object of my invention is to enable the application of brake-shoes to car wheels by fluid pressure to be effected with greater rapidity and effectiveness than heretofore, more particularly in trains of considerable length, as well as to economize compressed air in the operation of braking by utilizing in the brake-cylinders the greater portion of the volume of air which in former practice was directly discharged into the atmosphere."

"To this end my invention, generally stated, consists in a novel combination of a brake-pipe, an auxiliary reservoir, a brake-cylinder and a 'triple-valve' device governing, primarily, communication between the auxiliary reservoir and the brake-cylinder; and secondarily, communication directly from the brake-pipe to the brake-cylinder."

It was in accordance with the instructions given in the above quotation as to the object of the invention, and what it con-
90 sisted in, that I reached the understanding as to what the several combinations of devices particularly pointed out in claims 1, 2 and 4 were, and if this understanding is what is referred to by the terms "broadly construed," then it is manifest that my understanding was not reached upon the assumption or even the fact that Mr. Westinghouse was the first in the art to invent a "quick-action triple-valve" mechanism for air brakes.

My understanding of the law as inquired about is that even with the fact, as I understand it to be, that Mr. Westinghouse was the first in the art to invent a "quick-action triple-valve" mechanism, that this fact does not entitle him to claim the quick-action result or effect however produced, if by these words no regard is

had to mechanism or means employed in producing such result or effect, for, as I understand it, "a result" or "effect" is not patentable.

My understanding is that Mr. Westinghouse is only entitled to claim the "mechanical devices" combined together by means of which he is enabled to accomplish the quick-action effect or result; or, in other words, that he is only entitled to claim mechanisms or instrumentalities combined together in substantially the manner set forth to accomplish such quick-action effect or result, and also that each individual mechanism or instrumentality may differ from the form in which he has seen fit to illustrate it, in the drawings of said patent, so long as such difference does not prevent the combinations of devices or mechanisms or instrumentalities, as a whole, from accomplishing such result or effect in substantially the same way as set forth in said patent 360,070.

X Int. 12. Assuming that Mr. Westinghouse was the first in the art to invent a quick-action triple-valve mechanism, do you understand that such fact would authorize the claims in suit to be construed more broadly than as expressed by their own terms?

A. I do not understand that the fact that Mr. Westinghouse was the first in the art to invent a "quick-action triple valve" or an automatic quick-action system of brakes, is a sufficient war-
91 rant for ignoring or overriding any of the terms expressed in any of the claims of said patent 360,070, if this is what is intended by the language of the question; but I do understand that such fact authorizes the widest range of mechanical equivalents within the terms of said claims, and therefore that the said claims are to be understood as being as broad as the terms themselves will warrant and are not to be limited by a prior state of the art.

X Int. 13. Do you understand that Mr. Westinghouse was the first in the art to combine "a brake-pipe," an "auxiliary reservoir," a brake-cylinder and a "triple-valve" device, governing, primarily, communication between the auxiliary reservoir and the brake-cylinder, and, secondarily, communication directly from the brake-pipe to the brake-cylinder?

A. Yes, I do.

X Int. 14. Inasmuch as the quotation contained in my last question is taken from the specification of the patent in suit, I will ask you what meaning you attach to the words "primarily" and "secondarily," contained therein. Do those words relate to the relative times or sequence of the functions referred to, or to their relative importance, or to their logical order of statement?

A. My understanding of the terms "primarily" and "secondarily," referred to in the question, is that the word "primarily" refers to the "primary" functions of a triple valve by means of which the two first classes of work heretofore referred to by me can be performed, and the word "secondarily" to the new or secondary function by means of which "quick action" as heretofore explained can take place, and the third class of work as heretofore explained can be performed.

X Int. 15. Omitting the words "primarily" and "secondarily," I will restate my 13th X Int. as follows, to wit:

Do you understand that Mr. Westinghouse was the first in the art to combine a brake-pipe, an auxiliary reservoir, a brake-cylinder, and a "triple-valve" device governing communication between the auxiliary reservoir and the brake-cylinder, and also govern-
92 ing communication directly from the brake-pipe to the brake-cylinders?

A. Yes, if there is to be any difference in the two "communications," which I understand is the case in the use of the word "directly" in connection with the last-named "communication," viz., communication directly from the brake-pipe to the brake-cylinder.

X Int. 16. That is to say, if a brake-pipe, an auxiliary reservoir, a brake-cylinder, and a triple-valve device are combined together in a brake mechanism, so that the triple-valve device governs communication from the auxiliary reservoir to the brake-cylinder, and also governs communication directly from the brake-pipe to the brake-cylinder, then, in such case, the combination embraces the invention set forth in the patent in suit, and, as you understand the art, Mr. Westinghouse was the first to produce such combination?

A. The present question, as I understand it, does not necessarily make any difference between the two "communications," that is, the "communication" between the main air or train pipe, auxiliary reservoir, brake-cylinder and atmosphere, and the direct communication from the main air or train pipe to the brake-cylinder, which two communications are indicated in Complainants' Exhibit Defendants' 1891 Catalogue, plate XI, by two series of arrows: one series, which is in full lines, indicating the first "communication," and the other, or series of arrows in broken lines, indicating the last or direct "communication." The language of the question is broad enough to include a construction where only the ordinary functions of a "triple valve," or where the first two classes of work heretofore referred to are performed, and where fluid pressure passing through the "triple-valve" device may reach both the auxiliary reservoir and brake-cylinder at the same time, but yet the air so entering the brake-cylinder is not utilized therein for any useful purpose in applying the brakes, nor would it in any way affect an adjacent "triple valve" so as to hasten or quicken its operation. In this last-named construction there is no difference between
93 the two "communications"—in fact there is only one "communication"—and there is no "communication directly from the brake-pipe to the brake-cylinder," as I understand the term "directly" when read in the light of the preceding paragraph of the specification relating to the object of the invention.

From the above it will be seen that the several devices named in the question may be combined together so as to have one capacity, or radically another or entirely different one, and that this depends upon facts not stated in the question.

X Int. 17. My question stated, however, in plain terms, that the "triple-valve" device governed a communication from the auxiliary

reservoir to the brake-cylinder, and also a communication "directly" from the brake-pipe to the brake-cylinder—using the very terms found in the specification of the patent in suit on page 1, lines 20 to 27. I do not understand how you assume such two "communications" to consist, by any possibility, in only one "communication." Will you please explain yourself a little further on this point?

A. Upon reference to the previous question it will be seen that the language used is as follows, regarding the action of the triple valve—

"the triple-valve device governs communication from the auxiliary reservoir to the brake-cylinder, and also governs communication directly from the brake-pipe to the brake-cylinder."

And from this it will be seen that the previous question did not make it plain that there was two communications, and that only one communication would answer the language of that question, and because it would so answer it I answered the previous question in the manner in which that answer is found.

While it is true that some of the terms found in said previous question are found in the said specification, I did not then understand, nor do I now understand, that they are to be read in the
light of the specification of patent 360,070, but that they are
94 to be read as they appear and without anything else to assist
in explaining the exact meaning counsel may have had in mind.

If I am to understand by the present question that the previous one is to be read in the light of the specification of said patent 360,070, I desire to be now informed before proceeding further with the present answer, and will so request counsel to inform me.

X Int. 18. The specification, in the part to which I referred and from which I substantially quoted in my question, mentions a triple-valve device governing communication between the auxiliary reservoir and the brake-cylinder, and, if I understand the language employed, also governing communication directly from the brake-pipe to the brake-cylinder.

Using these terms in my question, without any mental reservation or qualification whatever, I merely asked you whether or not you understand Mr. Westinghouse to have been the first in the art to combine a brake-pipe, an auxiliary reservoir, a brake-cylinder and a triple-valve device governing communication between the auxiliary reservoir to the brake-cylinder, and also governing communication directly from the brake-pipe to the brake-cylinder—and, I confess, that I did not see, and do not now see, how a communication from the auxiliary reservoir to the brake-cylinder can be the same thing as a communication directly from the brake-pipe to the brake-cylinder, and, hence, I assumed them to be two "communications."

With this explanation, I ask you to answer the question again.

A. With the present explanation I understand that there are to be two "communications," and that they are to be different from each other, that is, a portion of one or the "communication directly"

is to be entirely different or separate from all portions of the other, and with such understanding I believe the fact to be that "Mr. Westinghouse was the first in the art to combine a brake-pipe, an auxiliary reservoir, a brake-cylinder and a 'triple-valve' device governing communication between the auxiliary reservoir
95 and the brake-cylinder, and also governing communication directly from the brake-pipe to the brake-cylinder," as stated in X Int. 15.

X Int. 19. Then, if I understand you, it is an essential characteristic of Mr. Westinghouse's mechanical combination, distinguishing it from the prior art, that the communication" directly from the brake-pipe to the brake-cylinder referred to in lines 26–27, page 1, of the specification shall be "entirely different or separate from all portions of the other communication," to wit: the communication between the auxiliary reservoir and the brake-cylinder referred to in line- 24–25 on the same page. Am I correct?

A. You are not correct, and I am wholly unaware of having said anything which would warrant such an understanding.

In my answer to the previous question, which related simply to the fact whether Mr. Westinghouse was the first to do certain things, I stated that with the explanation as then given by counsel, that in his statement of the fact, that a portion of one communication was to be entirely separate from all other portions of the other communication, which in reference to that fact, I believe to be true, but I did not say nor mean to be understood as saying that it was an essential characteristic or distinguishing feature of the combination of said patent 360,070 that such entire separation of a portion of one communication must necessarily be present in every structure which would be substantially identical with that of the several combinations of devices or mechanisms particularly pointed out in claims 1, 2 and 4 of said patent.

I think it will be manifest to a mechanic skilled in the art of automatic systems of brakes as the same existed prior to the date of said patent 360,070 and with the knowledge to be obtained from the said patent 360,070 that the two "communications" might be made with no one portion of one entirely separated from the other under all conditions of use, and yet have the structure perform substantially the same work, by substantially the same means, com-
96 bined substantially in the same way, and to work in substantially the same manner.

It will also be observed that no such requirement is made by the terms of the several terms referred to.

In view of the above several facts it is not my opinion that it is an essential or characteristic feature of the several combinations of devices or mechanisms heretofore referred to, that some portion of the direct communication between the "brake-pipe," or as heretofore termed the main air or train pipe, and the brake-cylinder, must necessarily be separate and distinct from all portions of the other "communication," that is, from the auxiliary reservoir to the brake-cylinder.

X Int. 20. In this specification, page 1, lines 20 to 28, Mr. West-

inghouse is trying to state, in general terms, what his invention consists in; and I am trying to find out what he means by this statement, and not what the claims mean, nor what a mechanic skilled in the art may understand from something else.

In order to understand the meaning of the statement of Mr. Westinghouse, I desire to ascertain, first, how broadly this statement could be interpreted, in view of the state of the art, and yet be true. I confess that I do not understand the distinctions which you have made, and I will, therefore, ask you again: Was Mr. Westinghouse the first in the art to combine a brake-pipe, an auxiliary reservoir, a brake-cylinder and a triple-valve device governing communication between the auxiliary reservoir and the brake-cylinder and communication directly from the brake-pipe to the brake-cylinder—whether those two "communications" were entirely separate from each other or partially coincident with each other?

A. Upon turning to that portion of the specification referred to in the question, it will be found that a portion of Mr. Westinghouse's statement has been omitted in the present question, the same as in some of the preceding ones, which omitted portions I have heretofore given my understanding of, which I think makes per-
97 fectly plain my understanding of what is meant by the statement found in the specification which is referred to in the question.

If this is what counsel desires I will refer him to that answer for such understanding.

If he desires to know simply the fact whether Mr. Westinghouse was the first in the art to devise an automatic system of brakes made in accordance with a portion of the statement as found in the specification, which portion is named in the present question, that will depend wholly upon what meaning may be put upon certain words contained in that portion, and which I have tried to make plain in my previous answers, but from the statements found in the present question, it appears that I have not been successful.

I will again attempt to make this matter plain. As I now understand the matter there are to be two "communications" between the brake, main air or train pipe and the brake-cylinder, one of which is from such pipe to the auxiliary reservoir and thence to the brake-cylinder, by means of which fluid pressure or air from the auxiliary reservoir is admitted to the brake-cylinder upon a reduction of the pressure in the brake, main air or train pipe below that in the auxiliary reservoir, and by means of which the two first classes of work heretofore referred to are performed; the other of which is from such pipe directly to the brake-cylinder without the fluid pressure which is to pass through the direct communication being able to enter the auxiliary reservoir, for if it did so enter it would not be a direct admission from such pipe to such cylinder.

In order that these two communications between the brake, main air or train pipe and the brake-cylinder may be had, it is necessary that some portion of one "communication" shall be separate from all portions of the other "communication," or shall be different in extent, which difference in extent is substantially making that por-

tion which does differ, to the extent of its difference, separate from all portions of the other "communication."

With this understanding, Mr. Westinghouse was, so far as
98 I am able to learn, "the first in the art to combine a brake-pipe, an auxiliary reservoir, a brake-cylinder and a triple-valve device governing communication between the auxiliary reservoir and the brake-cylinder, and communication directly from the brake-pipe to the brake-cylinder," so as to accomplish the object set forth on page 1 of the specification, lines 10 to 19, inclusive, of said patent 360,070.

Answer objected to as evasive and not responsive.

X Int. 21. Mr. Westinghouse either was or was not the first in the art to broadly combine, in an automatic brake mechanism, the following elements, to wit: A brake-pipe, an auxiliary reservoir, a brake-cylinder, and a triple-valve device governing communication between the auxiliary reservoir and the brake-cylinder, and also governing communication directly from the brake-pipe to the brake-cylinder.

I simply want to know whether he was or was not the first in the art to broadly combine the elements which I have stated in my question.

If you know the fact you can fully answer the question by yes or no; and if you don't know, you can say so.

I want an answer to the question, which I now repeat.

A. I have at no time attempted nor have I any desire to evade answering the preceding question, nor any other which has been asked me, and I have attempted to make my answers responsive to the other questions.

It will be remembered that at the beginning of the questions relating to this subject, that I pointed out the fact to be that, under one understanding of substantially the same question when broadly considered, that Mr. Westinghouse was not the first to combine those several elements regardless of the manner in which they were combined, and thereupon counsel, as I understood it, dis-
99 claimed any such broad interpretation of his language, and that the question was to be answered with the understanding that there was to be "two communications," under which understanding of the question I have heretofore answered.

As I understand him now he wants the question answered broadly, without any reference to the way in which they are combined, or whether they are two separate communications or only one, or to accomplish the object set forth in that portion of the specification of patent 360,070, to which I referred in my preceding answer.

Answering the question broadly, as I thus understand it, I should answer it no, as I have in substance heretofore done, but answering it when the several elements are combined together to accomplish the object set forth in the specification, I should answer it yes.

It will be observed that after stating the object of the invention, the specification goes on to say:

"To this end my invention, generally stated, consists in a novel combination," &c.

X Int. 22. Inasmuch as Mr. Westinghouse was not the first in the art to broadly combine, in an automatic air-brake mechanism, the elements named in my last question, will you state where, in the prior art, that broad combination is to be found?

A. I believe it is to be found in British letters patent of about the year 1879.

X Int. 23. And when Mr. Westinghouse stated in line 21, page 1, of his specification, that his invention, "generally stated," consisted in a "*novel* combination" of the elements named in my last two questions, he is to be understood as implying, in accordance with the known state of the art, that his invention did not consist broadly in a combination of the elements named, but only in their combination in a particular way; am I correct?

A. If the term "broadly" means that the several elements, no matter how combined, or what object is to be accomplished, I think he is to be understood as implying that his invention lay in the combination to which he refers by means of which the object stated could be accomplished, and that it did not lay in any and every combination of these parts by means of which other and radically different objects could be obtained, or, in other words, that his invention lay or consisted in the combination of such parts, by reason of which combination the object stated in the specification is accomplished and what has become known as "quick action," or the third class of work heretofore referred to is accomplished.

I understand that every combination of mechanisms or instrumentalities is a combination in a "particular way," in so far that every combination which is substantially identical with it must be combined in substantially that way.

If this is which is meant by the term "particular way" in the present question, it is manifest that it does not differ from what I have just heretofore stated the invention of Mr. Westinghouse consisted of.

If, on the other hand, the term "particular way" in the present question is to be understood as meaning that some one or more of the mechanisms or instrumentalities mentioned in the last few preceding questions are to be in themselves limited or constructed otherwise than as stated in such questions, then I should answer that the invention of Mr. Westinghouse did not consist in combining such several mechanisms or instrumentalities in such a "particular way."

Adjourned to meet at same place, tomorrow, July 23d, 1891, at 10 o'clock a. m.

R. H. WHITTLESEY,
Special Examiner.

101 NEW YORK, *July 23d*, 1891.

Met pursuant to adjournment.
Counsel present as at last meeting.

Cross-examination of the witness HENRY F. NEWBURY resumed:

X Int. 24. In the specification of the patent in suit, page 4, lines 91 to 103, there is a statement in the nature of a disclaimer, in the following words, to wit:

"I am aware that a construction in which 'an always-open one-way passage' from the main air pipe to the brake-cylinder is uncovered by the piston of the triple valve simultaneously with the opening of the passage from the auxiliary reservoir to the brake-cylinder has been heretofore proposed, and such construction, which involves an operation different from that of my invention, I therefore hereby disclaim."

I suppose you understand that the construction here referred to as existing in the prior art was the construction patented to George A. Boyden, June 26th, 1883, No. 280,285, for improvements in fluid-pressure brakes, do you not?

A. I understand that the said patent of Boyden was the particular cause of the statement quoted in the present question being placed in said patent 360,070.

I also understand that it has reference to any construction other than that set forth in the Boyden patent which comes within its terms, such as, for instance, as one of the constructions set forth in the British letters patent heretofore referred to by me as being granted about the year 1879.

X Int. 25. There are several mechanical terms and expressions in the patent in suit whose exact definition and meaning I wish to make clear to the court, not by prolix discussions of their functions and surroundings, but by concise and clear definitions, and
102 by brief and direct answers to such questions as I shall ask, and by these words I mean no reflection whatever, but simply indicate what I want to get at.

For example, claim 1 of the patent speaks of "a triple valve," and claim 4 speaks of "a triple-valve device." Do you understand these two expressions as used in said two claims to mean one and the same thing, or that there is any difference in their meaning?

A. I will endeavor to make my answers as brief as the nature of the questions will permit, and yet give a clear understanding of what I understand the meaning of the terms to be, but it must be borne in mind that every term has different meanings, in a measure, when used under different circumstances, and in connection with different language. It will also be borne in mind that it is somewhat difficult to express these different meanings in language, without more or less explanations.

I simply mention these facts to show that what counsel requires is a somewhat difficult matter, and that while I may appear to go

BLEED THROUGH POOR COPY

beyond the limits he has seen fit to name, that I do so only in an endeavor to make my understanding clear.

The specification of the patent itself as I have heretofore stated, defines what was referred to therein by the terms "triple valve" and "triple-valve device," which is probably as concise and brief a statement as I could make, therefore I will again quote it at this point.

"In using the terms 'triple valve' and 'triple-valve device,' I refer to a valve device, however specifically constructed, having a connection with the main air or brake pipe, another with the auxiliary reservoir or chamber for the storage of power, and another with a brake-cylinder or its equivalent for the utilization of the stored power, and with a release or discharge passage for releasing the operative power from the brake-cylinder, whether the valves governing these passages or connections are arranged in one
103 or more cases and are moved by a piston or its equivalent,
or by a series of pistons or their equivalents, there being numerous examples in the art, of constructions varying materially in appearance, whereby these functions are performed, both in plenum and vacuum brake mechanisms."

I understand these "functions" referred to in the above quotation are the ordinary functions of a "triple valve," as I have heretofore explained them, and by means of which the two first classes of work heretofore referred to by me are performed.

The term "triple valve," as the same is used in claim 1 of said patent 360,070, as I understand the same, is one of these mechanisms which has the capacity of performing the functions referred to in the above quotation, as I have explained the same, and which "triple valve" forms one of the mechanisms or instrumentalities which are to be combined in a brake mechanism with the other mechanisms or instrumentalities therein named in the manner set forth in the specification of said patent 360,070.

The term "triple valve," as used in said claim 1 of patent 360,070, may be in a single case, casing or chest, or it may be in a portion of a case, casing or chest, which also contains all of the other mechanisms or instrumentalities specified in said claim 1, but, whether in a case, casing or chest, which also contains the other mechanisms or instrumentalities specified in said claim, or in a separate case or otherwise, it is to have the capacity of performing the ordinary functions of a "triple valve" as I have heretofore explained them, and also have the capacity of actuating an auxiliary-valve device through a contact or connection with the piston of the "triple valve."

The term "triple-valve device," as the same is found in the said claim 4 of patent 360,070, it will be observed, is used in connection with the following words:

"4. The combination, in a triple-valve device, of a case or
104 chest," and then follows the other mechanisms or devices par-
ticularly pointed out in said claim 4.

From this it will be seen that the several mechanisms or instrumentalities particularly pointed out in said claim 4 are to be com-

bined together in a "triple-valve device," and that one case, casing or chest is to contain all the several mechanisms or instrumentalities named in said claim 4 of patent 360,070, and, therefore, the said claim 4 is necessarily limited to having its several mechanisms or instrumentalities combined in one case; that is, combined with the operative parts of a "triple valve."

The "triple-valve device" of the said claim 4 is necessarily a device which not only performs the ordinary functions of a "triple valve" as heretofore explained by me, but also has the capacity of performing another and distinct function, which function is that now known in the art as "quick action."

I understand the term "triple-valve device," as the same is used in said claim 4, to be the same as if the words "quick action" had been prefixed thereto, so as to have the words of said claim quoted in the present answer read as follows:

4. The combination, in a quick-action triple-valve device, of a case or chest.

From the above it will be seen that there is a difference in the meaning of the two terms "triple valve" as used in claim 1, and "triple-valve device" as used in claim 4 of said patent 360,070; that is, while both of them have the capacity of performing the ordinary functions of a "triple valve," and in this respect are alike, yet they differ in that one has an additional function from the other.

X Int. 26. So, also, I find in claim 1 the expression, "an auxiliary-valve device," and in claim 4 the expression, "an auxiliary valve." As employed in said two claims, are these two expressions synonymous, or of different meaning?

105 A. As I understand the term auxiliary-valve device as the same is used, it is broad enough to cover not only the valve itself, but its casing or chest and necessary connections with the several parts named in the said claim 1, while in the case of the term "auxiliary valve" as used in said claim 4, I understand that it refers more particularly to the valve itself, the casing or chest of which is a portion of the casing or chest of the "triple-valve device," in which the "auxiliary valve" is combined and located.

In the above respect the terms "auxiliary-valve device," and "auxiliary valve," as the same are used in the claims 1 and 4 respectively, are somewhat different in meaning, although they refer to substantially the same things, for it is manifest that in order to have a valve perform functions of such a device it must be supplied with a casing, otherwise it would be impossible for it to perform such functions.

While the two terms differ somewhat, as before stated, the term "auxiliary-valve device" includes the term "auxiliary valve," or, in other words, the former term is somewhat broader in scope than the latter one, as the two terms are used in claims 1 and 4 of said patent 360,070.

X Int. 27. Do you understand the term "auxiliary-valve device," as used in claim 1, to include the valve itself, the air passage

controlled by said valve, and the check-valve arranged in said passage?

A. I do not understand that the check-valve, which is arranged in the passage leading directly from the brake, main air, or train pipe to the brake-cylinder, is necessarily a portion of the auxiliary-valve device of claim 1 of patent 360,070, as I fully stated in my direct examination when considering such claim.

The check-valve referred to in the question I understand to be check-valve 49 in the form in which the patentee saw fit to illustrate his invention in the drawings of said patent 360,070, which check-valve is especially designed, as I understand it, to serve the purpose of holding fluid pressure or air in the brake-cylinder upon the breaking in two of the train, or the bursting of the brake,
106 main air, or train pipe, so that the fluid pressure or air in
such pipe is allowed to escape or be so greatly reduced from any cause that the brakes would not be applied by reason of the escape of the auxiliary reservoir pressure from the brake-cylinder as fast as it expanded or escaped into it, except for the use of said check-valve.

X Int. 28. Do you understand the expression, "auxiliary valve," as used in claim 4, to include said check-valve?

A. I do not understand that the term "auxiliary valve," as used in said claim 4, to include the check-valve to which I referred in my previous answer, and which I understand to be the check-valve referred to in the present question.

X Int. 29. In your opinion, would the Westinghouse quick-action device, in the form shown in the patent in suit, be a practical device without said check-valve or its equivalent—all the other parts being present and constructed and arranged as shown in the drawings of said patent?

A. I would ask counsel to define his meaning of the term "practical device," before proceeding with my answer.

X Int. 30. When I asked whether it would be a practical device, I mean would a device so constructed be successful and satisfactory in practice, as an air-brake mechanism on railway trains; or, in other words, would it be such a device as railroad companies would be likely to adopt and use?

A. As I understand the term as now defined by counsel, it takes in the widest possible range of all things which would go to induce a railroad company to adopt the device inquired of, regardless of whether such device would perform a useful function or not.

I think at the present day that any railroad company would be extremely loth to adopt any air-brake system in which there was no provision made for stopping the detached portions of a train upon such train breaking in two, and that any device which had this defect would not be likely to be adopted by railroad com-
107 panies at the present time, no matter what the other good
qualities of the device or system might be.

X Int. 31. Then this check-valve or its equivalent is practically indispensable to the use of the quick-action device of the patent in suit, is it not?

If the term "practically indispensable" has reference to her a railroad company would adopt the device or not, as I rstand the term to be in the present question, it follows that provision, whether the mechanical equivalent or not for the k-valve, would have to be employed, so that trains, when they k in two, may have their detached portions stopped, before rail- companies would be likely to adopt such device, notwithstand- he fact that they might recognize at once the useful functions ormed by such quick-action device unprovided with a check- e or some other means of preventing the escape of fluid press- or air from the brake-cylinders, as heretofore described.

Int. 32. Are not locomotive engineers, in making emergency , liable to reduce the train-pipe pressure to such an extent said check-valve or its equivalent is necessary to prevent re- of the air from the auxiliary reservoir and brake-cylinder in ordinary use of the quick-action system?

It is possible, I believe, for a locomotive engineer under the ement of a pending accident to so reduce main air or train pressure that there may be some "reflux of air," which I un- and to be an escape or expansion of fluid pressure or air from brake-cylinders to the main air or train pipe, but this could occur after the "quick action" had taken place throughout ength of the train, and the brake applied to the several cars of rain in much quicker time than was possible with any system rakes before known, which fact alone would be of great conse- ce in the saving of life, and, what is more, I believe the brakes ld be applied with greater force than would be possible in mak- a "service stop," or in any automatic system devised prior to that of the said Westinghouse system.

It will be borne in mind that whatever "reflux of air" or escape or expansion of fluid pressure which may take place the brake-cylinders back to the brake, main air or train pipe, not escape therefrom, but augments the pressure still remain- therein, and causes the pistons of the several "quick-action e valves" to be forced forward, so as to close the opening or munication governed or controlled by the auxiliary valve or iliary-valve device, before all of the pressure or air which first ped from such pipe to the brake-cylinders to return, and tever amount of such first direct admission or escape of main or train pipe pressure, which took place from such pipe to the ke-cylinders which did not return, would remain in such cylin- and augment the pressure or air escaping or expanding from auxiliary reservoirs into such cylinders and increase the force which the brakes would be applied to the wheels of the train n extent corresponding to the amount of main air or train pipe sure which remained in the brake-cylinders.

nother fact which would enable the brakes to be applied with ter force in making an "emergency stop," with the said check- e 49 omitted from the structure, than is possible when making service stop," is that the main air or train pipe pressure which lowed to suddenly escape at the engine to the extent of reduc-

ing the pressure or air in such main air or train pipe to the extent of 20 pounds, as explained by me in my direct examination, reduces such main air or train pipe pressure to such extent only at a point adjacent to its escape at the engine, and not throughout the entire length of the train as is necessary when making a service stop. Therefore a very much smaller amount of fluid pressure is allowed to escape from the main air or train pipe to the atmosphere, as a whole, when making an "emergency stop," as above stated, than when making a service stop, and from this it results that the fluid pressure or air to be utilized in applying the brakes is greater
109 in the case of an "emergency stop," for this reason alone, than it is when making a "service stop."

From the above it will be seen that while some "reflux of air" or return of fluid pressure or air may take place from the brake-cylinder to the main air or train pipe, yet such "reflux" or return does not prevent the said quick-action triple valve unprovided with the check-valve 49, from serving an exceedingly useful purpose and performing work never before accomplished by any automatic system before known.

X Int. 33. Then, if I understand you, you think it would be entirely practical to use on railway trains the quick-action device of the patent in suit, with the check-valve 49 omitted, were it not for the danger of the train becoming accidentally broken in two or the train-pipe ruptured; am I correct?

Counsel for defendant states that this question does not need nor call for a repetition of the endless discussion to which we have been listening, but is a plain, simple, direct question that can be fully answered inside of three minutes. The witness, however, demands an adjournment for lunch before answering the question, or at least a good reason for requiring the question to be answered before lunch; and intimates that the answer is to be a very long one.

Counsel is willing to give the reason for requiring the question to be answered now, which is, that if it be answered fully and fairly, it will close the discussion on this point, so that after lunch we can take up another subject of inquiry.

Counsel therefore insists upon the question being answered before adjournment.

Counsel for complainants does not recognize the right of counsel for defendants either to limit the time in which questions shall be answered or to dictate the hour of adjournment for lunch. Such adjournment being, as counsel understands, merely a matter of mutual convenience, and it now being 1.10 p. m., about the
110 hour at which adjournment is usually made, there does not seem to be any good reason for deferring an adjournment if the witness desires one to be made now, and the examiner is requested to so note.

Defendants' counsel replies that he has no desire to dictate the length of the witness' answer, but he does most emphatically protest against the further continuation of the abuses to which counsel has been already subjected in being obliged to listen to irrelevant

and not responsive interminable discussions where the question calls for simple, direct answers, and anything more than such an answer is a useless waste of time, simply annoying to the examining counsel and expensive to both parties. And with this statement he leaves the witness to decide whether he will answer the question or insist upon an adjournment.

Witness states that it is considerably over three hours since the present session commenced, and counsel states that if the present question is not answered in what he terms "fully and fairly," that the present answer will not close his discussion on the present point, and, therefore, it may continue indefinitely; he desires that the adjournment for lunch take place at this time.

Adjourned at 1.20 p. m. until 2 o'clock p. m.

R. H. WHITTLESEY,
Special Examiner.

Met at 2 o'clock p. m. pursuant to adjournment.

A. Understanding the term "practical" used in the present question as the same as defined in substance by counsel in a previous question, I do think that the main objection, and, in fact,
111 substantially the only objection, railroad companies would have to the adoption of "the quick-action device of the patent in suit, with the check-valve 49 omitted," is the fact that without such check-valve or some other means provided to prevent the return or escape of fluid pressure or air from the brake-cylinders to the brake, main air, or train pipe, and thence to the atmosphere upon the occurrence of the breaking in two of the train, or the rupturing of such pipe, and thus giving a free and unobstructed escape of fluid pressure or air from such pipe to the atmosphere, and thus preventing the application of the brakes to the separated portions of the train as heretofore explained.

In connection with this opinion I desire to call attention to the fact that this "quick-action" feature of "the quick-action device of the patent in suit with the check-valve 49 omitted" would be very useful when applied to railway trains in connection with the ordinary automatic system of brakes, each system being separate and distinct from the other, and that trains so equipped would provide for all contingencies, and if no better application of the quick-action principle had been devised, that some railroads, in my opinion, would probably adopt it in that form, but this would hardly be the case with a cheaper and simpler application of the quick-action principle as, for instance, such a one as disclosed in the preferred form of the patentee Westinghouse, and which is illustrated in the drawings of the patent in suit, wherein full provision is made for the contingency of the breaking in two of the train or the rupturing of the brake, main air, or train pipe, as well as the application of the quick-action principle to substantially its full extent.

Of course, with the choice of either the preferred form of the invention of the patent 360,070, or the form named in the present question, where the check-valve 49 is omitted or a substitute for it,

which would prevent the "reflux of air" or return of fluid pressure of air from the brake-cylinder to the main air or train pipe upon the breaking in two of the train or the bursting of the main
112 air or train pipe, combined with the old automatic system, as I have just heretofore described, there is no doubt in my mind but what railroad companies would every time adopt the said preferred form, for the reason it is cheaper, simpler, and would under all circumstances apply the brakes with as much or greater force than the other form, which is the form wherein check-valve 49 is omitted and includes the old automatic system of brakes as above described.

From this it will be seen that the omission of the check-valve 49 may not be the only reason why railroad companies would not be likely to adopt "the quick-action device of the patent in suit with the check-valve 49 omitted," and that other considerations, such, for instance, as cheapness or better application of the quick-action principle, might, and, in my opinion, probably would, influence them in reaching a decision upon the matter, and such a decision is what I understand counsel to mean by the term "practical," as the same is used in the present question.

Defendants' counsel requests the examiner to note that this last answer commenced at 2.02 o'clock and ended at 2.39 o'clock.

X Int. 34. You have several times in your testimony mentioned "the preferred form" of the quick-action device of the patent in suit; do you find in this patent more than one form of quick-action device referred to, or any intimation that Mr. Westinghouse at the date of that patent knew of more than one form of quick-action device, except the suggestion on page 4 of the specification, lines 85 to 93, to wit, in substance, that the device may be used with air pressure, or with "atmospheric pressure"?

A. I do find more than one form referred to, and also exceedingly distinct intimations that Mr. Westinghouse, at the date of said patent 360,070, knew of more than one form of such quick-action device.

X Int. 35. Designate all such passages in the specification?

113 A. In the first place the several claims particularly point out different forms of a quick-action device, each one differing from the other, therefore, the claims alone refer to more than one form of quick-action device, and I cannot understand how the patentee, Westinghouse, could make those claims without his knowing of at least as many different forms as are particularly pointed out in the said several claims, and, therefore, there are distinct intimations found in the patent itself that Mr. Westinghouse knew of more than one form of such quick-action device.

The specification of said patent 360,070 contains the statements which I have quoted in full at least twice during my deposition, and also otherwise referred to quite a number of times therein, which statement will be found on page 4, beginning at line 68 and ending at line 85 thereof, wherein it is specifically stated in substance that one of the essential devices, mechanisms or instrumen-

alities may vary within limits therein defined, and each of such variations would be a change in the form and arrangement of certain parts of such essential device, mechanism or instrumentality, which would be in effect a change in form of a quick-action device, and in effect the statement that he knew of as many different forms as existed in the prior art of "triple valves;" and such statement is also a reference to other forms of such quick-action device.

The statement of the object of the invention, taken in connection with what it consists in when generally stated, as the same is found on page 1, lines 10 to 27 inclusive, is a distinct intimation that the patentee Westinghouse knew of more than one form of quick-action device, for, if such was not the case, I cannot understand why he should be particular to put in the words "generally stated" as those words are found in lines 20 and 21 of page 1 of the specification of said patent 360,070.

It will be observed that on page 1, lines 96 to 98 inclusive, of said patent 360,070, it is stated that—

"In the accompanying drawings figure 1 is an inverted plan view illustrating the application of my invention;"

114 and that it does not state that figure is an illustration of the invention; also that on page 2, lines 7 to 51 inclusive, states that,

"In the practice of my invention, each railroad car 1——

Counsel for the defendant- interrupts the witness to inquire if he proposes to consume the time in quoting on the record forty-four printed lines of the specification which the court and all parties interested can readily find and read in the patent exhibit in evidence. If he does, counsel objects.

Witness states that he had not any intention of quoting the entire paragraph referred to, but that he named the lines wherein the matter would be found, so that it could be referred to without delay if thought necessary; and he also states that he has no desire to consume the time, as intimated by counsel for defendants, as the amount of work accomplished each day will, in his opinion, show a desire to expedite matters as far as circumstances will permit.

(Witness resumes:) "on which it is applied, as heretofore, provided with a main air pipe, 2, governed, &c."

naming the several parts in like order, being careful to, in each case, say, *a main air pipe, an auxiliary reservoir*, instead of saying *the main air pipe, the auxiliary reservoir*, &c., which is clearly an intimation that these several parts may be of a different form than what they are shown in the drawings of the patent 360,070, and therefore an intimation that the patentee had in mind or knew of other forms.

In the same paragraph will be found the following words, after setting forth the functions "of a triple valve 10":

115 "the triple valve 10 accords substantially with that set forth in letters patent of the United States No. 220,556, granted

and issued to me October 14th, 1879, and is not, therefore, saving as to the structural features by which it performs the further function of effecting the direct admission of air from the main air pipe to the brake-cylinder, as presently to be described, claimed as of my present invention."

This statement is explicit that the illustrated form of "triple valve" is not of the invention which the patentee Westinghouse was to claim in said patent 360,070, and is, to my mind, a distinct intimation, to say the least, that he, the patentee, knew of a different form than that illustrated, and that he wished it to be distinctly understood that such illustrated form was the form in which he preferred to illustrate his invention.

The specification of said patent 360,070, page 2 thereof, commencing at line 52, states as follows:

"The case or chest in which the operative mechanism of the triple valve proper, 10, is mounted, is fixed under or on the car body in any convenient position relatively to the auxiliary reservoir 6 and brake-cylinder 7, being in this instance shown as secured directly to one end of the auxiliary reservoir, in line axially therewith and with the brake-cylinder, which is secured to its opposite end."

This statement is, to say the least, an intimation that the devices or mechanisms named therein might be differently arranged from what they are shown in the preferred or illustrated form found in the drawing of patent 360,070, and when taken with other portions of the specification to which I have referred, is an intimation that the patentee Westinghouse knew of another form or arrangement of parts of a quick-action device, than that particularly illustrated in said drawing.

116 In the specification of the patent 360,070, on page 3, thereof, lines 37 to 47, inclusive, reference is made to three several letters patent, one of which is the one 220,556, before referred to, the other two being Nos. 168,359 and 172,064, and it is stated in substance that the form of "triple valve" set forth in said three patents accords in all substantial particulars with the form of "triple valve" illustrated in the drawings of said patent 360,070 as the same has been described in that portion of the specification preceding the reference to these three patents.

From an inspection of these three several patents just referred to, it will be seen that the "triple valves" therein set forth vary somewhat in construction, which being the fact, the statement referred to is an intimation that the patentee Westinghouse knew of more than one form of "triple valve" which might form one of the essential devices, mechanisms, or instrumentalities which go to make up a "quick-action" device.

The above I believe are all the portions or passages of the specification itself, aside from the general principle that the patentee is only required to show and describe one form in which he sees fit to embody his invention, that I find make reference to more than one form of quick-action device, or give intimation that Mr. Westinghouse at the date of that patent knew of more than one form of

quick-action device, of course keeping in mind the exception named in the question.

Adjourned to meet at same place tomorrow, Friday, July 24, 1891, at 10 o'clock a. m.

R. H. WHITTLESEY,
Special Examiner.

117 NEW YORK, *July* 24, 1891.

Met pursuant to adjournment.
Counsel present as at yesterday's meeting.

Cross-examination of the witness HENRY F. NEWBURY resumed:

X Int. 36. You have stated that by the backward movement of valve 41 (which is the auxiliary valve of complainants' patent in suit) there is practically an open passage from the main air or train pipe to the brake-cylinder, through the ports and passages and chambers 17–18–20–11–42–43–46–47 and 48, so that main air or train pipe pressure can, under certain conditions pass directly to the brake-cylinder.

I now ask you if those parts which you have designated by numbers as referred to above, together with the valve 41, constitute the "auxiliary-valve device" named in claim 1 of the patent in suit?

A. I believe that the designation of the several passages, ports and chambers, as stated in the question, occurred in that portion of my deposition wherein I described the construction and operation of the preferred or illustrated form of the invention, that is, the form in which the patentee saw fit to adopt as one embodiment of his invention, so that it might be fully described.

I do not understand that the "auxiliary-valve device" of the said claim 1 of patent 360,070 is necessarily to be provided with all of such ports, passages, &c., for upon turning to said claim it will be there seen that the only requirements in terms of the "auxiliary-valve device," are to be that it is to be independent of the main valve of the "triple valve," and is to be so actuated by the piston of the "triple valve," so that it will admit air in the application of the brake directly from the main air or train pipe to the brake-cylinder.

The preferred or illustrated form of the invention of the patent in suit has the several passages, ports and chambers named
118 in the question, some of which are common to the passages and ports and chambers leading from the main air or train pipe to the auxiliary reservoir, and when a passage is open from the main air or train pipe to the auxiliary reservoir, main air or train pipe pressure would pass through the portions common to both passages.

From all of the above I think it will be manifest that all of the several parts forming the practically open passage from the main air or train pipe to the brake-cylinder which I designated by numbers when describing the illustrated or preferred form of the inven-

BLEED THROUGH POOR COPY

CARD 2

and issued to me October 14th, 1879, and is not, therefore, saving as to the structural features by which it performs the further function of effecting the direct admission of air from the main air pipe to the brake-cylinder, as presently to be described, claimed as of my present invention."

This statement is explicit that the illustrated form of "triple valve" is not of the invention which the patentee Westinghouse was to claim in said patent 360,070, and is, to my mind, a distinct intimation, to say the least, that he, the patentee, knew of a different form than that illustrated, and that he wished it to be distinctly understood that such illustrated form was the form in which he preferred to illustrate his invention.

The specification of said patent 360,070, page 2 thereof, commencing at line 52, states as follows:

"The case or chest in which the operative mechanism of the triple valve proper, 10, is mounted, is fixed under or on the car body in any convenient position relatively to the auxiliary reservoir 6 and brake-cylinder 7, being in this instance shown as secured directly to one end of the auxiliary reservoir, in line axially therewith and with the brake-cylinder, which is secured to its opposite end."

This statement is, to say the least, an intimation that the devices or mechanisms named therein might be differently arranged from what they are shown in the preferred or illustrated form found in the drawing of patent 360,070, and when taken with other portions of the specification to which I have referred, is an intimation that the patentee Westinghouse knew of another form or arrangement of parts of a quick-action device, than that particularly illustrated in said drawing.

116 In the specification of the patent 360,070, on page 3, thereof, lines 37 to 47, inclusive, reference is made to three several letters patent, one of which is the one 220,556, before referred to, the other two being Nos. 168,359 and 172,064, and it is stated in substance that the form of "triple valve" set forth in said three patents accords in all substantial particulars with the form of "triple valve" illustrated in the drawings of said patent 360,070 as the same has been described in that portion of the specification preceding the reference to these three patents.

From an inspection of these three several patents just referred to, it will be seen that the "triple valves" therein set forth vary somewhat in construction, which being the fact, the statement referred to is an intimation that the patentee Westinghouse knew of more than one form of "triple valve" which might form one of the essential devices, mechanisms, or instrumentalities which go to make up a "quick-action" device.

The above I believe are all the portions or passages of the specification itself, aside from the general principle that the patentee is only required to show and describe one form in which he sees fit to embody his invention, that I find make reference to more than one form of quick-action device, or give intimation that Mr. Westinghouse at the date of that patent knew of more than one form of

iick-action device, of course keeping in mind the exception named the question.

Adjourned to meet at same place tomorrow, Friday, July 24. 891, at 10 o'clock a. m.

R. H. WHITTLESEY,
Special Examiner.

7 NEW YORK, *July* 24, 1891.

Met pursuant to adjournment.
Counsel present as at yesterday's meeting.

Cross-examination of the witness HENRY F. NEWBURY resumed:

X Int. 36. You have stated that by the backward movement of ilve 41 (which is the auxiliary valve of complainants' patent in it) there is practically an open passage from the main air or train pe to the brake-cylinder, through the ports and passages and aambers 17–18–20–11–42–43–46–47 and 48, so that main air or ain pipe pressure can, under certain conditions pass directly to e brake-cylinder.

I now ask you if those parts which you have designated by num-ers as referred to above, together with the valve 41, constitute the auxiliary-valve device" named in claim 1 of the patent in suit?

A. I believe that the designation of the several passages, ports id chambers, as stated in the question, occurred in that portion of y deposition wherein I described the construction and operation the preferred or illustrated form of the invention, that is, the rm in which the patentee saw fit to adopt as one embodiment of s invention, so that it might be fully described.

I do not understand that the "auxiliary-valve device" of the id claim 1 of patent 360,070 is necessarily to be provided with all such ports, passages, &c., for upon turning to said claim it will there seen that the only requirements in terms of the "auxiliary-ilve device," are to be that it is to be independent of the main ilve of the "triple valve," and is to be so actuated by the piston the "triple valve," so that it will admit air in the application the brake directly from the main air or train pipe to the brake-linder.

The preferred or illustrated form of the invention of the patent in suit has the several passages, ports and chambers named

8 in the question, some of which are common to the passages and ports and chambers leading from the main air or train pe to the auxiliary reservoir, and when a passage is open from e main air or train pipe to the auxiliary reservoir, main air or ain pipe pressure would pass through the portions common to th passages.

From all of the above I think it will be manifest that all of the veral parts forming the practically open passage from the main r or train pipe to the brake-cylinder which I designated by num-rs when describing the illustrated or preferred form of the inven-

tion, are not necessary in order to constitute "the auxiliary-valve device" named in claim 1 of said patent 360,070, that is, while such parts may constitute one form of "the auxiliary-valve device" named in such claim, that they do not necessarily constitute the only form, and that "the auxiliary-valve device" named in said claim 1, may have a practically open passage from the main air or train pipe to the brake-cylinder, made up of any number of ports, passages and chambers that may be thought desirable by the constructor, so long as such "auxiliary-valve device" meets the requirements named in said claim 1, and so long as it does meet those requirements and performs the work in the combination of opening and closing or governing communication directly between the main air or train pipe and the brake-cylinder, so that the combination as a whole is substantially the same as it is now, then such an "auxiliary-valve device" would be the "auxiliary-valve device" named in said claim, no matter whether it had the specific form and arrangement of ports, passages and chambers or not, as the same are found in the preferred or illustrated form shown in the drawings.

X Int. 37. Does the specification describe or the drawings illustrate more than one passage for the admission of air directly from the drain-cup 19 to the brake-cylinder in making an emergency stop?

A. The drawings illustrate only one form of the invention, and the specification does not describe in detail but that one
119 form, which form I have heretofore termed the preferred or illustrated form, and as I have heretofore stated, such one form contains the several ports, passages and chambers referred to in the previous question.

X Int. 38. That one passage for the admission of air from the drain-cup 19 directly to the brake-cylinder in making an emergency stop, as described in the specification and illustrated in the drawing, consists of the port 42, chamber 43, passage 46, chamber 47, and passage 48; does it not?

And in answering this question, which refers only to what the specification describes and the drawings illustrate, please confine your answer to the question without going into long and irrelevant details and theories that are not asked of you.

A. The illustrated form of the passage and the one described in detail in the specification between the points named in the illustrated or preferred form is comprised of the parts named in the question, which are the same parts between the same points, which I named in my direct examination when describing such preferred or illustrated form, and will be found in the order named in X Int. 36.

X Int. 39. Does the specification anywhere describe or allude to any other passage for the admission of air directly from the drain-cup 19 to the brake-cylinder in making an emergency stop, than the passage designated by the figures 42, 43, 46, 47, 48?

If so where does it describe or allude to such other passage?

A. I have repeatedly stated that the specification describes but one form of the invention.

Defendants' counsel interrupts the witness to say that he is not asking about the invention, but about this particular air passage; and if it be possible for the witness to give a direct answer to a fair question, he requests him to do so.

Witness resumes: At this point I will say that I have
120 repeatedly answered the question, and I will again answer it, and that this preferred or illustrated form was shown and described in detail, and that it was the only form which was so shown and described, and in this form the passage was made up of the ports, passages and chambers as designated in the question.

If the term "allude" means an allusion to another specific form of passage, I would state that I do not find any such specific form alluded to; if, on the other hand, it means that there is anything alluded to in the specification that indicates there may be another form of passage, then I would say that I do not find in the specification such an allusion, and it will be found in my answer to X Int. 35.

X Int. 40. This passage 42, 43, 46, 47, 48, is not found in the mechanisms illustrated in the three letters patent Nos. 168,359, 172,064 and 220,556 referred to in the specification of the patent in suit, page 3, lines 42 and 43; is it?

A. The passage referred to in the question with an auxiliary valve or auxiliary-valve device, governing or controlling communication directly from the main air or train pipe to the brake-cylinder, is not found in either one of the patents referred to in the question.

X Int. 41. Question repeated and a categorical answer demanded.

A. In making my answer to the preceding question, I understood "this passage" of said question to be one which had like functions to the passage 42, 43, 46, 47, 48 of that question, and with the necessary appliances to perform such function, and that there might not be any mistake, I in substance stated my understanding of the passage in question and then fully answered the question. From the fact that the question is repeated I am led to believe that the question is intended to mean something else, and while such is the case, I am at loss to understand how it is possible to make a categorical answer. In my previous answer I simply adopted the form of the question in my answer in order that it might be thoroughly responsive, the form of the question being, "is not found," * * * "is it," and I answered, "is not found."

121 X Int. 42. Now, without further evasion, will you be good enough to answer X Int. 40 just as it stands?

A. I cannot answer the question more fully than I have already done, for the reasons stated in my answer to the previous question.

X Int. 43. My question, X Int. 40, names a specific passage and asks if you find that passage in any of the three prior patents referred to. Do you want the court to infer that you are mentally incapable of understanding so simple a question; or, on the other hand, that you do understand it and refuse to answer it?

A. I have not, as I am aware, refused to answer the question, but on the contrary have answered it fully, as will appear.

There is not the slightest hesitancy in answering the question to the fullest extent on my part, that I am aware of, and the only thing I want the court to understand is that I do not wish to have my answers quoted as meaning something entirely different from what I intended to say, and I believe that this much I am entitled to.

I do not understand now that there is any question but that I have fully answered X Int. 40, but it is simply a question of form only. If I have not answered it fully I am entirely willing to so answer it, as I have not the slightest desire to evade answering any definite question that may be propounded to me.

Recess until 2 o'clock p. m.

X Int. 44. I asked you whether a certain air passage which is marked 42, 43, 46, 47, 48 in the patent in suit, is to be found in any of the prior three patents named in my 40th X Int., to which you replied in substance that it was not to be found there performing the same functions or provided with an auxiliary valve to control it. It is perfectly clear that such an answer is not responsive to my question; and I again repeat the question and demand a responsive answer.

122 A. As I now understand the question it relates to the specific form of the passage, and with such understanding I would answer that it is not found in either one of the patents referred to in said X Int. 40.

X Int. 45. My question did *not* relate to the specific form of the passage, but to the *substance* of the passage. Do you find in any of said three patents *any* passage, of *any* form, leading from the drain-cup to the brake-cylinder and through which air passes directly from the train-pipe or drain-cup to the brake-cylinder in the act of making an emergency stop?

A. I understood when I answered the said X Int. 40, that it did relate to the substance and made my answer in the form that there could be no doubt about it, and I believe the answer was thoroughly responsive to the question.

When the question was repeated I could not but think that it related to something else or some other passage that did not have the function of the passage 42, 43, 46, 47, 48, in what has become known as "emergency stops," and therefore made my several answers as they appear.

I do not in any of said three patents find *any* passage of *any* form leading from the drain-cup to the brake-cylinder through which air passes "directly" from the train-pipe or drain-cup in the act of making what has become known as "emergency stops."

X Int. 46. That passage, with the auxiliary slide-valve 41 controlling it, constitutes substantially the mechanical instrumentality which Mr. Westinghouse added, in his patent No. 360,070, to his old automatic air-brake mechanism, or, in other words, constitutes the auxiliary-valve device of the patent No. 360,070—does it not?

A. The passage 42, 43, 46, 47, 48, with the auxiliary valve 41, controlling the same, constitutes the mechanical instrumentality which the patentee, Westinghouse, saw fit to adopt in illustrating and describing his invention in connection with the form of "triple valve" which he also saw fit to adopt for the same purpose, and in
123 one sense it may be said that he added such passage and auxiliary valve to his former triple valve as the same is shown in his prior patent 220,556, which, with other modifications in such triple valve, enabled him to illustrate his invention which required a different manipulation of the main air or train pipe pressure over that which was necessary with such old form of "triple valve," and thereby make possible the third class of work to which I have heretofore referred, and which is now known as "emergency stops," and when such invention is in the preferred or illustrated form, as shown in the drawing of patent 360,070, such passage and auxiliary valve would then constitute an auxiliary-valve device substantially identical with that of the patent in suit in its general characteristics.

It will be borne in mind that said patent in suit refers to more than one form of auxiliary-valve device as I have heretofore explained, and therefore the term, "the auxiliary valve device of the patent No. 360,070," is indefinite. If it means that such passage and auxiliary valve *from* the auxiliary-valve device of the preferred or illustrated form, then I would answer that such passage and auxiliary valve does constitute the auxiliary-valve device of such preferred form; but if, on the other hand, it is intended to mean that such passage and auxiliary valve constitutes the auxiliary-valve device of the claims in the sense that the form and arrangement are essential, then I should answer that such passage and auxiliary valve do not constitute the auxiliary-valve device of the patent in that sense.

If the question simply refers to the patent in a general way, without any reference whatever to the form or arrangement of such passage and auxiliary-valve device, except that the form and arrangement is such as will enable the passage and auxiliary valve to perform the function of admitting main air or train pipe pressure directly to the brake-cylinder in substantially the same way as set forth in said patent, then with such an understanding as to the meaning of the question, I would answer that such passage
124 and auxiliary valve do constitute the auxiliary-valve device of the patent No. 360,070.

X Int. 47. I consider it perfectly clear that the patent itself refers to only one form of auxiliary-valve device, to wit: the form described in the specification and illustrated in the drawings; but waiving further discussion of this matter, I now ask you whether, whatever may be the form of the auxiliary-valve device, the patent requires that the valve which performs the function of admitting air from the main pipe to the brake-cylinder is to be separate from that which effects the preliminary admission of auxiliary reservoir pressure to said cylinder?

A. I understand the question to refer to the auxiliary-valve de-

vice by means of which the direct admission of main air or train pipe pressure to the cylinder is controlled, and with such understanding, I do not understand that the patent requires that such auxiliary-valve device shall in all cases be separate from the one which effects the preliminary admission of auxiliary reservoir pressure to said cylinder. If by the term "separate" it is meant that such auxiliary valve is to be a separate and distinct piece of material, which is the meaning I understand the word "separate" to have in the present question.

To make my meaning plain, I will state that, as I understand the matter, the auxiliary valve by means of which main air or train pipe pressure is admitted directly to the brake-cylinder, and the valve by means of which the preliminary admission of auxiliary reservoir pressure to the brake cylinder is controlled, may be one and the same piece of material, the only difference being a difference in extent of the opening or port by means of which the two functions are performed, or a difference in the location of the ports alone, so that the two movements of the piston of the "triple valve," to which I referred in my direct examination, is enabled to control or govern communication directly from the main air or train pipe to the brake-cylinder upon the second or further movement or traverse of such piston and the first or preliminary movement or traverse of such triple-valve piston, controls or governs communication between the auxiliary reservoir and the brake-cylinder.

125

X Int. 48. How, then, do you explain the language of claim 1, where it speaks of the auxiliary-valve device being actuated by the piston of the triple valve and *independent* of the main valve thereof; and what meaning do you give to the word "independent" in this connection?

A. The previous question was not limited to any particular claim, but included the patent as a whole, and I answered it with that understanding and without reference to all the limitations that would be found in all the claims of the patent, or in other words, I answered the question in the broad sense in which I think it would be naturally read.

In my direct examination wherein I set forth the essential devices, mechanisms or instrumentalities which go to make up the brake mechanism particularly pointed out in said claim 1, and the differences existing between the illustrated or preferred form of the patent in suit and the said "Exhibit Defendants' Quick-action Triple Valve," I fully pointed out the characteristics of each one of the essential devices, mechanisms or instrumentalities of the brake mechanism of the said claim 1, and I think I therein explained the language of said claim 1, which is referred to in the present question, but I will again state my understanding in regard to such language.

So far as the brake mechanism particularly pointed out in said claim 1 is concerned, the auxiliary-valve device of that claim is to be one adapted to open direct communication between the main air or train pipe and the brake cylinder, and which is independent of

the valve which performs the main or primary functions in applying and releasing the brakes, and is also adapted to be actuated in one direction by reason of contact or a connection between the piston of the triple valve and the auxiliary-valve device, and that, to meet the above characteristics of such auxiliary-valve
126 device of said claim 1, I used the term independent in the ordinary sense as I understand the same and as it is used when applied to the preferred form illustrated in the drawings of the patent in suit. That is, it was to be a separate piece of material from that of the valve which performed the main or primary functions in applying and releasing the brakes, and that the valve which performs such main or primary functions has a movement separate and distinct from the movement of the auxiliary-valve device; that is, that the two do not at all times move together.

It will be observed that the main valve or the valve which performs the main or primary functions in applying and releasing the brakes of the preferred or illustrated form shown in the drawings, under certain conditions moves with the auxiliary valve, or in other words, such auxiliary valve moves with such main valve during a portion of the movement of such main valve.

Therefore I do not understand that the term "independent," as found in said claim 1, can mean anything more than I have just set forth, and I give the term "independent" the above meaning in my direct examination and have understood it to be such since then, and also had this meaning in mind when I answered the previous question.

It will be observed that no such term or requirement is found in claim 2 of said patent 360,070, and I specially had in mind such claim 2 when answering the previous question.

As counsel has, off the record, expressed a desire that I extend my answer to claim 4, I will so extend it.

An inspection of such claim 4 will show that there is no requirement in terms in such claim, that the auxiliary valve of such claim shall be independent of the valve which performs the main or primary functions in applying and releasing the brakes, as is the case in the brake mechanism particularly pointed out in said claim 1.

I do not understand that the "triple-valve device" particularly pointed out in said claim 4 requires that the auxiliary valve
127 of such device must necessarily be independent or separate from the valve which performs the main or primary functions in applying and releasing the brakes.

X Int. 49. Then, if I understand you, claims 2 and 4 cover the combinations respectively referred to therein, whether the auxiliary valve be integral with or separate from the valve which effects the preliminary admission of reservoir pressure to the brake-cylinder; am I correct?

A. Yes; so far as that particular feature goes you are correct.

X Int. 50. In the Westinghouse automatic air-brake mechanisms in general use in this country from the year 1879 to the beginning of the year 1887, especially, for example, in the mechanism shown

in the patent of Mr. Westinghouse dated October 14, 1879, N 220,556, how was the "emergency stop" effected?

A. I do not understand that what has become known as "emer gency stops" in connection with "quick-action triple valve," o "automatic quick-action systems of brakes" was possible with th Westinghouse automatic system as it existed, and exemplified a referred to in the question.

Of course collisions and accidents were liable to occur in thos days the same as they are now, and it was desirable then to avoi such accidents if possible by stopping the train in the shortest pos sible space and time regardless of all other considerations, but a before stated the quickest space of time and shortest distance i which the train could be stopped was by allowing a steady escap of fluid pressure from the main air or train pipe of the engine, which required an action of all the "triple valves" throughout th length of the train precisely the same as I have described in con- nection with the second class of work I have heretofore referred to, when such "service stop" was made by a continuous reduction of main air or train pipe as I have heretofore explained and not by a series of "graduating applications."

Or in other words the Westinghouse automatic system
128 of brakes which were supplied with "triple valves" like those shown and described in said patent No. 220,556, was capable of only performing the two first classes of work heretofore referred to by me, namely, that of "graduating" and "service stops;" the latter class of work then as now was performed either by a continuous escape of main air or train pipe pressure at the engine, or a series of "graduating applications" as desired, or dictated by the judgment of the engineer.

The above, of course, has reference to the manipulation of the brakes by the engineer on the locomotive or engine.

Adjourned to meet at same place on Saturday, July 25th, 1891, at 10 o'clock a. m.

R. A. WHITTLESEY,
Special Examiner.

NEW YORK, *July 25th*, 1891.

Met pursuant to adjournment.

Counsel present as at last meeting.

Cross-examination of HENRY F. NEWBURY resumed:

X Int. 51. Inasmuch as Mr. Westinghouse states, in substance, in the patent in suit, page 2, lines 37, &c., that the triple valve 10 accords substantially with that of his prior patent No. 220,556, we may take the triple valve of said prior patent No. 220,556 as fairly representative of the triple-valve devices employed by Mr. Westinghouse and his company in the interval between October, 1879, and March, 1887. Now, taking such triple valve as shown in said prior patent, did not said valve, in its preliminary backward movement to apply the brakes, admit auxiliary reservoir pressure to the brake-

cylinder and in its further or final backward movement again admit auxiliary reservoir pressure to the brake-cylinder?

129 A. In the "triple valve" shown and described in the said patent 220,556, there are two openings in the valve designated s^1, s^2, the latter being smaller than the former, but both of them are between the valve which opens the passage common to both of these openings and the brake-cylinder and these two openings s^2, s^1, are arranged in the line of the path of travel of the slide-valve in which they are placed, the distance between the two openings being less than the size of the port or passage with which they connect, but it is possible, upon a very slight reduction in main air or train pipe pressure in making a "graduating application," to bring the smaller opening s^2 in register with the port or passage C, when such port or passage C is closed or shut off from the port or passage E, by the movement of the slide-valve H, in which are arranged the openings s^1, s^2, so that auxiliary reservoir pressure can pass by the valve c^1, also arranged in the slide-valve H, through the passage c, into the opening s^2, and through it into the port or passage C, and thence to the brake-cylinder, and upon a correspondingly slight reduction——

Defendants' counsel interrupts the witness to state that his question inquires simply whether said triple valve in passing through its backward traverse preliminarily admitted reservoir air to the brake-cylinder, and then, in its further or final part of the traverse, again admitted reservoir air to the brake-cylinder. It either did or did not, and the question is fully answered by a direct affirmative or negative. It is a gross abuse of the witness' privilege and of counsel's rights for the witness to insist upon evading question after question and cumbering the record with tedious and tiresome discussion of details not asked about; and counsel again protests against this practice, which is apparently designed to render cross-examination useless.

130 Witness states that he has not any desire to evade the question and emphatically denies the assertions of counsel that the form of his answer is designed to render cross-examination useless.

the valve c closes the passage c in the slide-valve H, thereupon closing communication between the auxiliary reservoir and the brake-cylinder.

Upon a greater reduction of main air or train pipe pressure than the first, the triple-valve piston moves back to a greater distance and brings the passage s^1, in register with the port or opening C, and admitting auxiliary reservoir pressure through and past the unseated valve c^1, through the passage c, opening s^1, and port or opening C, to the brake-cylinder.

Therefore, it is true, upon the movement of the piston G a certain distance, which may be termed its preliminary movement, auxiliary reservoir pressure is admitted to the brake-cylinder, and that, upon a further movement, auxiliary reservoir pressure is again admitted to the brake-cylinder, and, by reason of the fact that the

slide-valve H can bodily move past the port or opening C leading to the brake-cylinder, auxiliary reservoir pressure is also again admitted to the brake-cylinder in still larger volume than either of the other two admissions and without any control of this last-named admission by the valve e^1 in the slide-valve H.

Owing to the fact that three admissions of reservoir pressure would take place with the form of triple valve illustrated in said patent and the question referred to only two, I have answered the question as it appears.

X Int. 52. In the form shown in Fig. 1, of said patent No. 220,556, when, in the backward movement of the piston, to apply the brakes, the back end of the piston stem g rests against the graduating stem b^1, without compressing the spring b^2, which port of the triple valve is in communication with the passage or port C leading to the brake-cylinder?

A. As near as I can make out the opening s^1 would be in communication with the port or opening C leading to the brake-cylinder.

131 X Int. 53. In that position auxiliary reservoir air would pass through the port s^1 and the port or passage C to the brake-cylinder, would it not?

A. It would as I have already described.

X Int. 54. Now, assuming a further reduction of train-pipe pressure, sufficient to cause the piston G to move further backward to the extreme limit of its backward traverse, so as to compress the spring b^2 and rest against the packing A^2, then, in that case, would the large port or passage C, which admits air from the reservoir to the brake-cylinder, be held open or closed?

A. The port or passage C would be open to its full extent, but would not be held open without a still further reduction in main air or train pipe pressure, owing to the fact that the expansion or escape of auxiliary or reservoir pressure into the brake-cylinder would reduce such pressure in the reservoir, and again close the port or opening C, by the forward movement of the piston G, and the valve H which is actuated by the piston, and this closure would take place in proportion to the equalization of pressures in the auxiliary reservoirs and main air or brake pipe, aided, of course, by the force exerted by the spring b^2.

X Int. 55. In case the train should break in two or the train-pipe become ruptured, the piston G would become seated against the packing A^2, opening the port or passage C wide open, and holding it wide open, and thereby applying and holding the brakes applied with the maximum force of which the auxiliary reservoir force is capable; would it not?

A. It would, because there would be a still further reduction of main air or reservoir pressure below the point necessary to bring the piston G in the position stated in the previous question, and I would state that I understand this to be the distinctive feature of the "automatic system of brakes" over and above what is known as "direct acting system of brakes," and is common to all "triple valves" adapted for use in the automatic system.

X Int. 56. So, also, if when running his train the engineer should discover imminent danger of collision or other accident
132 ahead, his duty would be to so exhaust the train-pipe pressure as to bring the triple-valve piston G into contact with packing A^2, and open the port or passage C, so as to suddenly effect the application of the brakes with the maximum pressure available in the auxiliary reservoir; would it not?

A. It would be his duty in the case named in the question, as it would also be in the case he was tardy in commencing the application of the brakes in approaching a station, or at any times when — was not making "graduating applications," to reduce main air or train pipe pressure, so that the pistons of each of the "triple valves" throughout the train would become seated and held against the packing A^2 of each one of such triple valves, but this could not be done suddenly in the sense in which we use that term in the "automatic quick-action system of brakes," owing to the fact that fluid pressure or air in the main air or train pipe would have to travel from the rear end of the train to the engine before the last triple-valve piston would be affected.

It will be borne in mind that I have already explained that "service stops" or the second class of work to which I have heretofore referred, could be made in two ways: one by a continuous escape of fluid pressure at the engine, and the other by a series of "graduating applications," and that under the circumstances stated in the question, the operation would be by a continuous escape of main air or train pipe pressure at the engine, and one of the ways in which such second class of work is performed, and no different under the circumstances named in the question than it would be under the condition named by me, that is, when the engineer was tardy in commencing the application of the brakes upon approaching a station, or did not wish to make the stop by a series of graduating applications.

X Int. 57. The brakes would be applied more quickly by full force by causing the piston G to move back and seat upon the packing A^2 than they would be applied by simply causing the stem g to move back and seat against the stem b^1 and thus merely put
133 the port s^1 in communication with the port C, is not this the fact?

A. It is true that a continuous escape of main air or train pipe pressure will apply the brakes more quickly than is possible with a series of "graduating applications," but in each case they can be applied with full force or the maximum force which the auxiliary reservoir pressure is capable of applying them; the only difference, as I understand, is the question of time of the two classes of stops.

X Int. 58. In figures 1 and 2 and 3 of patent No. 220,556 how is the main valve of the triple-valve device lettered or designated in the drawings?

Well, what do you mean by main valve; there is no such term in that patent, I believe?

Defendants' counsel replies that he leaves the witness to define the term as best he can.

A. The slide-valve, by means of which the port or opening leading from the valve chamber of the triple valve to the brake-cylinder is opened and closed to its fullest extent, and communication from the brake-cylinder to the atmosphere is closed, by means of which one form of service stop is made and the brakes in all cases are released, is lettered H, and so far as the functions of this slide-valve H and the small valve e^1, which is of the puppet type and has its seat in the slide-valve H, are concerned, and without regard to any other construction than that shown in said patent 220,556, I should term this slide-valve the main one of the two. The puppet valve e^1, which has its seat in the slide-valve H, is termed in the specification of said patent 220,556, an "auxiliary valve e^1."

X Int. 59. In claim 1 of said patent 220,556, the valve H is termed "the main valve," and the valve e^1 is termed "an auxiliary valve;" am I not correct?

A. I believe you are substantially correct, and in my hasty examination of the descriptive part of the specification I did not notice the claim; if I had, I should have stated the fact, or
134 at least not questioned counsel as to his meaning of the term "main valve." It will be observed that the slide-valve H, strictly speaking, is not termed the "main valve," although the term main valve is used in claim 1, and I understand such term to refer back to the valve H mentioned near the beginning of the claim.

X Int. 60. One of the functions of this main valve H, in the triple-valve device of patent No. 220,556, is the function of putting the port or passage C in communication with the auxiliary reservoir pressure when the triple-valve piston G compresses the spring b^2, and seats upon the packing A^2, is it not?

A. It is, as I have heretofore several times stated.

X Int. 61. In the backward movement of the triple-valve piston G, through its entire backward traverse, the puppet valve e^1 first unseats to effect a preliminary admission of reservoir air to the brake-cylinder, and then finally the main valve H puts the port or passage C again into communication with the auxiliary reservoir pressure; am I correct?

A. The brake-cylinder can only be put in communication with the auxiliary reservoir in all three cases heretofore named by and through the movement of the slide-valve H; simply unseating the puppet valve e^1, does not admit auxiliary reservoir pressure to the brake-cylinder, which can only take place by the operation of the slide-valve H. It is true that upon the combined unseating of the puppet valve e^1 and the operation of the slide-valve H auxiliary reservoir pressure can be admitted to the brake-cylinder through the passage in the slide-valve H, which is controlled by the puppet valve e^1, as when making "graduating applications," and also that when the piston G moves the slide-valve H, a still further distance in its backward movement, such valve H moves beyond the port

or passage C, and admits auxiliary reservoir pressure to the brake-cylinder.

But in each case it is necessary that the slide-valve H shall be operated, first, to close communication between the brake-cylinder and the atmosphere and then to admit auxiliary reservoir
135 pressure to the brake-cylinder through either one of the openings or passages s^2, s^1, and when the slide-valve H moves either partially or wholly from over the port or passage C.

X Int. 62. Then the main valve H assists in performing the function of preliminarily admitting the air from the reservoir to the brake-cylinder, upon the movement of the stem g, nearly into contact with the shoulder or enlarged portion of the stem b^1 (shown in said drawing figure 1, about half an inch below the stem g); but, by itself alone, and without the aid of the graduating valve e^1, the main valve H performs the entire function of the second or final admission of air from the auxiliary reservoir to the brake-cylinder, when the piston G reaches or closely approximates the extreme backward limit of its traverse; am I correct?

A. As I understand the matter you are not.

X Int. 63. Explain why not?

A. The reason why you are not correct is this: That the operation so far as the two admissions of auxiliary reservoir pressure to the brake-cylinder are concerned, without regard to the stopping of such admissions, but considering them as they take place upon the backward movement of the piston, are precisely the same as they would be if the puppet valve e^1 was entirely removed from the structure, which in effect is done by continuously holding it unseated throughout the entire backward movement of the piston G after the stem of such piston engages with the slide-valve H, and the only office of the puppet valve e^1 is, as I understand the matter, to shut off or stop the admission of auxiliary reservoir pressure to the brake-cylinder, when a less amount than the maximum force with which such auxiliary reservoir pressure will apply the brakes is desired, and without requiring any movement of the slide-valve H, so that the piston G will be relieved from the friction of the slide-valve H, and thus be far more sensitive to slight reductions in auxiliary reservoir pressure, and therefore making it possible to admit smaller quantities of auxiliary reservoir pressure to the brake-cylinders at each time or application.

The puppet valve e^1 is used, as I understand the matter,
136 in making what I have heretofore termed and has become known as "graduating application," and such puppet valve enables the engineer to "graduate" the force to a nicer or finer extent, which the auxiliary reservoir pressure admitted to the brake-cylinders, will exert in applying the brakes to the wheels of the train, than would be possible when the slide-valve H had to be moved, for the increased friction of the slide-valve H, and consequently the greater labor or work put upon the piston G, would require a greater reduction in auxiliary reservoir pressure, in order to move such valve at all, and when it is once started to move, such increased reduction would be liable to carry the piston G and slide-

valve H in a forward direction to an extent sufficiently to open communication between the brake-cylinder and the atmosphere, and thus release the brakes at the very time it was desired they should be applied to decrease the speed of the train or hold it in check upon a downgrade.

X Int. 64. To modify my last question a little: In effecting and controlling the preliminary flow of air from the auxiliary reservoir to the brake-cylinder, under the conditions stated in my last question, the main valve H and the auxiliary and graduating valve e^1 co-operate in the performance of said function, while in effecting and controlling the second or final flow of auxiliary air to the brake-cylinder, referred to in said question, the main valve H alone performs such function; am I not correct?

A. I understand that the function referred to as being performed by what counsel has termed "the preliminary flow of air from the auxiliary reservoir to the brake-cylinder," to be what is known as the function of "graduating," or the function performed in making "graduating applications," and with this understanding the auxiliary or graduating valve e^1 co-operates with the slide-valve H, and the two together perform such function, and it is the only function which I am aware of that the valve e^1 co-operates in perform-
137 ing, unless it can be said that it co-operates with the slide-valve H when it is absent from the structure entirely.

When the piston G moves backward with sufficient force to compress the spring b^2, and cause the slide-valve H to pass entirely beyond the port or passage C, the slide-valve H moves quickly so that the openings s^1, s^2, in such slide-valve, quickly pass over and past the port or passage C, leading to the brake-cylinder, and consequently there is no appreciable time for the expansion or escape of auxiliary reservoir pressure to the brake-cylinder any more than there is from the time that the end of the slide-valve H begins to pass beyond the port or passage C leading to the brake-cylinder; therefore the preliminary flow of air from the auxiliary reservoir or flow of air from the auxiliary reservoir to the brake-cylinder can be said to take place during the entire time that the slide-valve H is moving in a backward direction upon a continuous escape of main air or train pipe pressure at the engine, and the final flow, that which takes place or the escape or expansion of auxiliary reservoir pressure into the brake-cylinder after the slide-valve H has entirely uncovered the port or passage C leading to the brake-cylinder.

If the question has to do only with the backward movement of the piston G and the slide-valve H, there is no co-operation between the valve e^1 and the slide-valve H, as I have heretofore explained, and the only controlling of any flow of air from the auxiliary reservoir to the brake-cylinder or escape or expansion of auxiliary reservoir pressure to such cylinder that takes place by means of the valve e^1 is upon making a "graduating application," as I have heretofore explained: therefore, if there is to be any control by the valve e^1, it must necessarily be upon making a "graduating application, and any 'preliminary' flow of air from the auxiliary reser-

voir to the brake-cylinder," which is controlled by the said valve e^1, must necessarily be the flow which takes place when making a "graduating application" and not when the slide-valve H and piston G move backward to their extreme limit of their movement in that direction.

138 In making a "service stop" by a continuous escape of main air or train pipe pressure, so that the slide-valve H and piston G move backward sufficiently to wholly uncover the port or passage C leading to the brake-cylinder and hold the piston G in contact with the packing A^2, is to be considered "the second or final flow of auxiliary air to the brake-cylinder;" then the slide-valve H alone may be said to control such second or final flow, and for the reason stated above in connection with what counsel has termed "the preliminary flow of air from the auxiliary reservoir to the brake-cylinder."

If this so-called "second or final flow of auxiliary air to the brake-cylinder" is to be understood as that portion of the flow or escape or expansion of auxiliary reservoir pressure to the brake-cylinder which takes place through the port or passage C after the slide-valve H has moved backward to the extent of the limit of its movement in that direction, and it is held there until the brakes are applied with the maximum force with which the auxiliary reservoir pressure can apply them, then the slide-valve H only permits such escape or expansion of auxiliary reservoir pressure, and in no way controls it, and the amount of such pressure which does escape or expand into the brake-cylinder is determined and controlled by the amount of such pressure originally in the auxiliary reservoir, or, in other words, the escape or expansion of auxiliary reservoir pressure into the brake-cylinder ceases upon an equilibrium being established between the pressure in the brake-cylinder and the auxiliary reservoir, regardless of the slide-valve H.

From the above it will appear that you are not correct in both assumptions of the question upon either understanding as to the meaning of controlling "the preliminary flow of air from the auxiliary reservoir to the brake-cylinder," and also "controlling the second or final flow of auxiliary air to the brake-cylinder."

Under one understanding—that is, that the so called "preliminary flow" is the flow which takes place in making a

139 "graduating application" and that the "second or final flow" is the one which takes place upon the piston G moving backward to the extreme limit of its movement in that direction and held against the packing A^2—it will be manifest that the slide-valve H and the valve e^1 co-operate in effecting and controlling the "graduating application," and it is also manifest that the slide-valve permits or effects the escape or expansion of auxiliary reservoir pressure to the brake-cylinder, but that it does not in any way control such escape or expansion.

Under the second understanding—that the so-called preliminary flow is that which takes place during the backward movement of the slide-valve H, or any portion of it, upon a continuous reduction of main air or train pipe pressure, which will cause piston G to

POOR COPY

move backward to its extreme limit in that direction, and that the so-called "second or final flow" or expansion or escape of auxiliary reservoir pressure which takes place after the port or passage C is entirely uncovered or opened—then it is not true that the slide-valve H controls such so called "second or final flow," but only permits it, and in that sense effects such flow, escape, or expansion of auxiliary reservoir pressure to the brake-cylinder.

If, on the other hand, this so-called "second or final flow" or escape or expansion of auxiliary reservoir pressure to the brake-cylinder is to be considered that portion, which is substantially all which enters the brake-cylinder through the port or passage C from the time that the end of the slide-valve H begins to pass beyond and uncover or open the port or passage C, then the only control that the said valve H has over such flow, escape or expansion is that which it exercises before the port or passage C is entirely opened or uncovered by the backward movement of such valve H, but even considering such so-called "second or final flow" with this understanding, and that such flow is controlled and effected by the slide-valve alone, it would still be true that there would be no control by the valve e^1 upon the so-called "preliminary flow" upon the backward movement of the slide-
140 valve H to its extreme limit in that direction, and therefore
under any understanding I at the present time have of the question you would be incorrect, and for the reasons above set forth.

X Int. 65. In making a graduating application the piston G is moved backward till the end of its stem g rests against the stem h^1, which takes place when said piston has completed about one-half of its entire range of backward movement; am I correct?

A. Not entirely. A graduating application can be made that way, and it also can be made either before the piston has reached the position named in the question or has passed way beyond it.

X Int. 66. It is ordinarily made as I have described it, is it not?

A. That depends upon what is meant by ordinarily. I believe that that is the easiest and most certain way of making a "graduating application," and if "ordinarily" means this, then I should answer, yes.

X Int. 67. If, while making a graduating application in the manner described in my 65th X Int., the engineer should discover impending danger close ahead which the small graduating pressure that he had already applied to the brakes would be insufficient to avoid, his duty would be to further reduce his train-pipe pressure as quickly as possible so as to bring the piston G against the packing A^2, and open the port C wide open; would it not?

A. If the engineer, while making a graduating application in any manner possible with a triple valve like that shown and described in said patent 220,556, should discover impending danger close ahead, it would be his duty to continue such "graduating application" into a continuous reduction of main air or train pipe pressure until each and every triple-valve piston G in the train had become seated against its packing A^2 and held there

until an equilibrium in pressure was established in each individual auxiliary reservoir and its corresponding brake-cylinder, and thus change his "graduating application" into a "service stop" made by a continuous reduction of main air or train pipe pressure.

141 I do not understand that with "the automatic system of brakes" as it existed when triple valves like said patent 220,556 were used, that there was any difference whatever in the suddenness or quickness with which main air or train pipe pressure was reduced in making a "graduating application," or a "service stop," by a continuous reduction in main air or train pipe pressure, except in the difference in time which the engineer left his operating cock or valve open to the atmosphere for the escape of such main air or train pipe pressure. And also that the only difference between a "service stop" made by a series of "graduating applications" and one made by a continuous reduction in main air or train pipe pressure, when such "graduating applications" are made by the backward movement of the piston G until it comes in contact with the stem b^1, except from the time elapsing between each graduating application and the next one of the series, occurs from the difference in the capacity of the graduating passage, and that of the port or passage C leading to the brake-cylinder.

If the question by——

Defendants' counsel interrupts the witness to again protest against this inexcusable waste of time.

The witness states that owing to the indefiniteness of the question, he was going to continue his answer under what he thought barely possible might be the meaning of the question, but will desist in deference to counsel's statement just made.

X Int. 68. In making a graduating application the valve e^1 is moved backward in the passage e, which, in connection with the port s^1, extends through the main valve H, is it not?

A. It is during a portion of making such graduating application.

X Int. 69. That movement is necessary in order to permit

142 air from the auxiliary reservoir to pass through the main valve H, when the passage in the latter shall come into communication with port C, is it not?

A. Yes; I understand the term "air" to be compressed air or pressure in the reservoir above that in the brake-cylinder.

X Int. 70. And when the valve e^1 moves forward again it closes the passage through the main valve H, and thus stops the escape of air pressure from the auxiliary reservoir to the brake-cylinder, does it not?

A. It does, as I have heretofore explained.

Adjourned to meet at same place on Monday, July 27th, 1891, at 10.45 o'clock a. m.

R. H. WHITTLESEY,
Special Examiner.

NEW YORK, *July 27th*, 1891.

Met pursuant to adjournment.

Counsel present as at last meeting.

Cross-examination of the witness HENRY F. NEWBURY resumed:

X Int. 71. Before resuming the subject-matter under inquiry Saturday afternoon last, I desire briefly to digress to another matter.

There are two equity suits Nos. 4976 and 4977 pending in the circuit court of the United States for the southern district of New York. In No. 4976, the Westinghouse Air Brake Company sues the New York Air Brake Company *et als.* for alleged infringement, among other things, of the patent of Harvey S. Park, dated December 4th, 1888, No. 393,784, relating to improvements in quick-action automatic air-brake systems.

In suit No. 4977, George Westinghouse, Jr., and the Westinghouse Air Brake Company, as joint complainants, sue the New York
143 Air Brake Company *et als.* for alleged infringement, among other things, of the patent of George Westinghouse, Jr., dated January 24th, 1888, No. 376,837, relating also to improvements in quick-action automatic air-brake systems.

In both of said suits, one Henry F. Newbury was called and examined, and testified as an expert for the complainants. Are you the Mr. Newbury who testified in those suits as expert for complainants?

Objected to as not proper cross-examination, the matter inquired about not having formed any part of the witness' deposition-in-chief.

A. I did testify in two cases, which I believe to be the ones referred to in the question.

X Int. 72. In the case which involved the alleged infringement of the said Park patent, I find from the printed proof-sheets of your testimony therein, which I hold in my hand, that the 17th and 18th X Ints. and answers in your deposition were as follows, to wit:

"17 X Q. You admit, do you not, that the invention described in the Park patent 393,784 is either an improvement upon the inventions described in patents 360,070 and 376,837, or else a different apparatus from, whether better or worse than, the apparatus described in those two patents for accomplishing the same final result, namely, opening the valve which controls communication between the brake-pipe and brake-cylinder?

"A. As I understand the matter, said patent 393,784 is for an invention which is tributary to patent 376,837 and may be said to be an improvement upon the invention of the last-named patent, or it may be for an invention for accomplishing the same result, but with a somewhat different arrangement of parts. Whichever it is, it is for the court to say.

"I do not understand that the invention of said Park patent is tributary to patent 360,070, and so far as that patent
144 alone is concerned, the invention of patent 393,784 may be

said to be for a different combination of devices or elements by means of which the same final result, namely, a quick-action automatic system of brakes, is provided.

"18 X Q. In your answer you seem to think that you ought to construe the three patents named. My question did not relate at all to the breadth or scope of either of the patents, so I will repeat it in substance, changing its form.

"Will you not admit that the invention described in the Park patent and the inventions described in patents 360,070 and 376,837 are for the purpose of accomplishing the same result, namely, the operation and control of a valve which controls communication between a brake-pipe and brake-cylinder?

"A. The mechanisms or combinations of devices shown and described in the several patents named in the question are designed to accomplish one general object, namely, that of providing a quick-action automatic system of brakes."

In the other suit, which involved the alleged infringement of the Westinghouse patent, dated January 24, 1888, No. 376,837, I find from such printed proof-sheets now in my hands that cross-questions and answers 20 and 21 of your said deposition in such suit were as follows, to wit:

"20 X Q. Which of the three patents, 360,070, 376,837 and 393,784, do you regard as the pioneer or bottom patent so far as relates to quick-action triple valves?

"A. So far as regards the two first mentioned, I do not regard one as being the pioneer over the other so far as one controls the other, but it is a fact that patent 360,070 was granted at an earlier date than that of 376,837, and, as I have heretofore stated, I would rank them side by side and of equal importance so far as regards a quick-action automatic system of brakes.

145 "21 X Q. Don't you think it fairer, on the whole, to regard all three as of equal rank, but the first as the pioneer so far as regards controlling the valve which controls communications between the brake-pipe and the brake-cylinder by means of the triple-valve piston; the second as the pioneer so far as concerns controlling that valve by means of the triple valve itself, and the third as the pioneer so far as regards controlling that valve by means of an independent valve actuated by the triple-valve piston?

"A. No; I do not think that I can so regard them, because, as I look at the matter, I should regard the first as being the pioneer so far as regards the operation of the valve which controls communication between the brake or train pipe and the brake-cylinder, by means of the triple-valve piston acting mechanically upon it; and the second as the pioneer so far as regards the operation of such valve by auxiliary reservoir pressure acting independently of the triple-valve piston, and that these two are of equal importance; while the third I would regard as the pioneer in its distinctive feature, that is, that the valve which controls the communication between the brake or train pipe and the brake-cylinder is to be operated directly by brake or train pipe pressure instead of by aux-

iliary reservoir pressure; and this last was not of equal importance with the other two, so far as regards the art of quick-action automatic brakes."

These quotations from the proof-sheets of your depositions in said suits, correctly state the respective questions and answers in your testimony therein which they purport to state, do they not?

Same objection, and further objected to as irrelevant, immaterial and incompetent, it not being shown that the lengthy quotations of the question are copies or true copies of portions of the
146 witness' depositions in the suits referred to or in any other suits.

A. It is some time since I closed my depositions in the two cases referred to, and I have been engaged in testifying in quite a number of suits since that time, and at this time I would not attempt to testify as to the correctness of statements made upon proof-sheets from memory alone, for it is impossible for any person to carry details of depositions and be able to say whether anything, which purported to be a copy of the same, was correct or not, and for the above reasons I cannot state from memory alone whether the quotations made in the present question "correctly state the respective questions and answers" or not.

X Int. 73. Have you any reasonable doubt that the quotations contained in my last interrogatory are, in all substantial and material respects, correct copies of the respective questions and answers of which they purport to be copies?

Same objection, which, with protest against the improper consumption of complainants' time, is continued without further notice to this entire line of cross-examination.

A. I cannot state, for the reasons heretofore given, whether I have or have not any reasonable doubts upon the subject, and I have not given the matter sufficient attention or charged my memory sufficiently with the details of depositions after they are finished to be able to certify to the correctness of any alleged copy.

X Int. 74. In taking said depositions the examining counsel appear from the proof-sheets to have been Mr. J. Snowden Bell, for the complainants, and Mr. J. E. Maynadier, for the defendants; this is correct, is it not?

A. I believe it is.

X Int. 75. Your deposition in case 4976 appears to have begun on May 4, 1891, and concluded on May 7, 1891; and your
147 deposition in case 4977 appears to have begun on April 30, 1891, and to have continued, with various adjournments, till a date as late, at least, as May 20th, 1891; that interval between April 30th and the latter part of May, 1891, is about the time when you gave your testimony in the said cases, is it not?

A. I believe the two depositions were given somewhere about the times named in the question, but am under the impression that they closed earlier than the date named.

X Int. 76. In said depositions were you not asked by Mr. May-

BLEED. THRO

nadier questions substantially such as I have quoted in my 72d X Int. this morning, and is not the substance of your reply to those questions correctly stated in the answers which I have quoted purporting to be your answers to such questions?

A. I recollect that Mr. Maynadier asked some questions of somewhat of the import or nature of those named in said cross-interrogatory, and while I cannot say that the alleged answers so quoted are substantially correct, I believe that I replied in the general manner therein stated.

X Int. 77. Resuming now the subject of our discussion when I interrupted it this morning, I will ask your attention to the quick-action automatic brake mechanism illustrated in plate XI of the Boyden 1891 catalogue, about which you testified in your examination-in-chief. Referring to this plate XI and the reference letters marked thereon, I understood you to say in substance in your examination-in-chief that the check-valve 26 performed the function of admitting train-pipe pressure to the auxiliary reservoir for the purpose of supplying the latter with compressed air, and that in respect to the performance of such function it was the practical equivalent of the ordinary feed-groove employed for many years past by Mr. Westinghouse to perform such function; or in substance, that the triple-valve piston provided with a passage through it and a check-valve to control the passage as shown in said plate XI is, for the purpose of feeding train-pipe air to the auxiliary
148 reservoir, the practical equivalent of the ordinary Westinghouse triple-valve piston acting in connection with such feed-groove.

Do I understand your position correctly with respect to such matter?

A. If it had been added when considering claims 1, 2 and 4 of said patent 360,070, and the substantial identity of said defendants' quick-action triple valve, as the same is illustrated in said plate XI, with the combinations and devices particularly pointed out in said claims, I should answer that for such purpose you did understand my position correctly.

X Int. 78. Now, if we should take the apparatus of said plate XI, fasten the check-valve 26 fast to the hollow stem surrounding the opening F and integral with the triple-valve piston, so that the check-valve could under no circumstances lift from its seat, and then provide the triple-valve piston with a feeding groove like that marked 51 in the drawings of patent No. 360,070 here in suit, then the apparatus of plate XI of the Boyden 1891 catalogue would cease to act as a quick-action automatic brake apparatus, would it not?

A. I believe that it would.

X Int. 79. So modified, the triple valve of the triple-valve apparatus or mechanism shown in said plate XI would act substantially like the triple valve of the triple valve or mechanism shown in figures 1 and 4 of the patent of Westinghouse No. 220,556, dated October 14th, 1879; would it not?

A. That would depend entirely upon what meaning was given

to the term "substantially" in the question. If such term "su stantially" is understood as meaning that the so-modified Boyd triple valve would perform the two classes of work heretofo referred to by me, namely, making "graduating applications" a "service stops," I should answer that it would act in "substantially the same manner as the said triple valve of the said patent 220,55 the same as with all other forms of "triple valve" which, I believ preceded the date of the invention of the patent No. 360,07

149 If the term "substantially" is to have a more limite meaning, then I should answer that it would not, as will b manifest upon an inspection of the so "modified Boyden tripl valve," and the "triple valve" of the said patent 220,556.

The "triple valve" of the patent 220,556 is capable of admittin auxiliary reservoir pressure to the triple-valve chamber in large quantities or volume than can be carried from such valve chambe to the brake-cylinder, so that when the triple-valve piston, desig nated in said patent as G, is seated upon the packing A^2, the por or passage leading from such valve chamber to the brake-cylinder and which is designated in said patent as C, cannot allow auxiliary reservoir pressure to escape from such valve chamber any faster, o in fact not as fast, as such pressure enters such chamber, and from which it results that the slide-valve H and the port or passage C control the amount of auxiliary reservoir pressure which can pas at one time into the brake-cylinder, while this is not the fact with the "modified Boyden triple valve," and for manifest reasons.

There are other differences which I could point out when the term "substantially" is given the limited meaning which I have just above indicated, but will not at the present time consume the time necessary to do it.

X Int. 80. Assume that the Boyden valve device, modified as stated in X Int. 78, has its passage B of the same capacity as the passage C of patent 220,556; then, in such case, would not the triple-valve device of plate XI, so modified, act practically in the same manner and with the same effect as the triple-valve device shown in said figures 1 and 4 of patent No. 220,556; and if not, why not?

A. The present question is indefinite in substantially the same respect as the previous one, the term "practically" being substituted for "substantially," and when that indefiniteness is cured as in the answer to the previous question, then such answer would apply to the present question, as well as the reason therein given.

150 There is another matter of indefiniteness which has to do especially with the present question, although, in a measure, it applies to the previous one, and that is, when dealing with fluid pressures which exert different degrees of force according to the difference in the pressures, the slightest difference in openings or ports through which one pressure expands or escapes from one point of confinement to another is of great importance when considering what the pressure shall be at various points of confinement, and what the operative effect of such pressures may or will be, cannot be determined with any definiteness without all these

differences of ports, openings or passages being clearly defined in the structure under consideration.

The question has to deal with mere pictures, which do not even purport to represent the same construction, and also which do not purport to bear any relation whatever to one another—so far as sizes and proportions of the several parts of each are concerned.

From the above it will be manifest that the further modification of the present question over that of the one which preceded it is not one which would give any definite idea of what the modified construction would be.

I assumed that the largest one of the two openings C, one being shown in Fig. 1 and the other in Fig. 4 of the printed Patent Office copy of said patent 220,556, was the one referred to by counsel as the size of said passage which was to take the place of the one designated as B of the "modified Boyden triple valve" when I made up my answer to the present question from that of the previous one.

X Int. 81. Take the apparatus shown in plate XI of Boyden 1891 catalogue here in evidence, fasten the check-valve 26 to its seat so that it cannot separate therefrom, provide the apparatus with the feeding groove exactly like that marked 51 in patent 360,070, and make the passage B of the same capacity as the passage C of patent 220,556—and I don't care whether you assume the passage to be of the size shown in Fig. 1 or of the size shown in Fig. 4 of
151 said patent 220,556, for I regard that as entirely immaterial—
and then tell me if you understand this modified construction or understand what the Boyden structure would be as thus modified?

A. Of course, I have an idea of what the structure might be, but for the reasons heretofore given it is manifest that quite a number of structures could be constructed, from the description given, and have no two of them alike. What I might construct might differ from what counsel has in mind, and also from what several other persons might construct from the same instructions; and, therefore, if any two of them were alike it would be pure accident and not what the instructions contained.

Of course all of the several structures would probably perform the two first classes of work——

Counsel for defendant interrupts the witness to say that he is not asking about that, but whether he understands the modification as suggested—if the witness will answer the question as a witness, and not assume to act both as complainants' counsel and witness we should get along much faster and get something done.

to which I have heretofore referred and in this sense only they might be said to be *the* structure of the question, and in this sense only do I understand *the* structure of the question.

Of course I have an understanding of *a* construction, but whether it is *the* construction of the question I have no means of determining from the question itself.

X Int. 82. I assume all the parts shown in Fig. XI to be entirely unchanged except in the three particulars named in my question.

I assume the feed-groove to be precisely like that shown and mark 51 in the drawings of the patent in suit No. 360,070. I assume t passage B to be precisely the same as the passage B of plate XI the Boyden 1891 catalogue, except that it is made of t

152 same capacity for transmitting air pressure as the passage of patent No. 220,556. I assume the check-valve 26 of pla XI aforesaid to be simply fastened to its seat so as to be incapab of moving therefrom—how fastened is utterly immaterial—but prevent a long answer, I will further assume that it is fastened l brazing it to the metallic part of its seat. Now, as thus modifie do you understand the construction that I refer to—I mean, do yo know what it is?

A. Not a single fact stated in the present question which is co tained in the previous ones did I have in mind when I made m answer to the last preceding question.

I assumed that when——

Defendants' counsel interrupts the witness to request him to a swer the present question.

Witness states that he is making his best endeavors to do so, bu owing to the indefinite character of the question he is compelle to state certain facts so that his answer will not be misunderstood.

Counsel replies that the question is simply whether the witnes does or does not know what the mechanical structure referred to i the question would be, and this question can be answered by yes o no, for he either does or does not know what the structure woul be. Counsel is not asking in this question about its operation bu simply what it *is*.

considering what counsel meant when he referred to "the drawing of the patent in suit No. 360,070" and the "passage C of patent No 220,556," that he referred to the drawings of printed Patent Offic copies of the patent in suit and also the same as regards paten 220,556, and so stated in one of my previous answers, and I wil now state that I have no remembrance of ever seeing the actua patent in suit No. 360,070, nor the patent 220,556, and when

153 counsel has been formulating his questions he has held in his hand printed Patent Office copies of those patents.

To say the least, the present question is as indefinite as the preceding one, and, as I have before stated, I understand *a* construction or *a* mechanical structure which would meet all the terms of the question, but for the reason above stated I do not understand what *the* structure or *the* mechanical structure is.

X Int. 83. Do you understand the "structure" or the "mechanical structure," shown in figures 1 and 4 of patent 220,556, or is there some mysterious indefiniteness about this question, also, that only enables you to understand *a* structure, without being sure about *the* structure?

A. The "structure" shown in figures 1 and 4 of patent 220,556 is fully described in the specification, but as I remember said specification there is no statement as to the size or scale to which it is to be built, nor in fact do I remember any statement that the several

parts shown in those figures are to be constructed upon the scale therein shown, and as I understand the matter that any structure which formed the work——

Defendants' counsel interrupts the witness again to state that he has not asked him a question of law, nor what work any structure would perform, but simply whether the witness understands the construction of the structure shown in figures 1 and 4 of patent 220,556.

He will feel under great obligations if the witness will for this once at least confine his answer to the question that is asked him.

Witness considers that he is and has been complying with the above request.

that that structure will perform by means of the several devices combined, as there shown and described, is *the* structure of that patent, and this he believes he fully understands, but if the question intends to ask as to the actual dimensions which any one part of the structure is to be, then I would answer that I do not
154 understand "the structure," or "the mechanical structure"
in that sense, for as I understand it, the dimensions may be whatever the constructor may see fit to make them.

X Int. 84. I will assume that you understand the Boyden structure as modified in my 81st and 82d X Int., and that you understand the structure shown in patent No. 220,556, although it seems impossible to get you to say whether you do or not. Assuming that you do, I now ask you whether, in your opinion, the Boyden structure so modified is or is not the mechanical equivalent of the structure shown in patent 220,556 for the purposes of an automatic air-brake mechanism.

I call your attention to the fact that this question is a plain, simple question which can be answered affirmatively or negatively.

A. Understanding the term automatic air-brake mechanism as the same existed, that is, one which performs the first two classes of work to which I have heretofore referred, and considering the question broadly without special reference to the claim of said patent 220,556, I should answer Yes.

X Int. 85. In this question and the questions following, until I notify you to the contrary, I shall assume a Boyden structure modified as stated in my 81st and 82d X interrogatories, and place it in comparison with the structure shown in patent No. 220,556.

You have stated in substance heretofore in this examination that in applying the brakes for ordinary service stops or graduating applications, the valve e^1 of patent 220,556 first opens a passage through the main valve H, before the triple-valve piston G seats upon the packing A^2, and that when said piston seats upon said packing it opens the passage C, wide open, thereby admitting a fuller and freer flow of air from the auxiliary reservoir to the brake-cylinder.

Now, referring to the modified Boyden structure assumed in my question, in applying the brakes for an ordinary service stop or

graduating application, does not the stem 18, shown in plate XI of the Boyden 1891 catalogue, first move backward, just as the
155 Westinghouse valve e^1 moves backward under the same conditions, so as to admit air from the auxiliary reservoir to flow to the brake-cylinder, through a small port or passage, before the triple-valve piston 29 seats against the packing or washer marked 7; and when said piston seats against said packing 7, does not the valve marked 22 unseat, and admit a fuller and freer passage of air from the auxiliary reservoir to the brake-cylinder? I understand, of course, that the valve 22 of Boyden is not obliged to move in order to allow the passage through the stem 18 to open, while the main valve H, of patent 220,556, *is* obliged to change its position slightly in order to let air through the port opened by the back movement of the small valve e^1?

A. In the first place, the question seems to contain a statement somewhat at variance from anything which I have a recollection of saying, as I do not remember of stating, in substance, any such operation as is implied in this statement.

In my description of the operation of the "triple valve" set forth in said patent 220,556, I stated that the most convenient and certain way of performing or making a "graduating application" was to reduce the main air or train pipe pressure to a point sufficient to cause the piston G, with its stem g, to come in contact with the stem b^1, and in that sense, that was the ordinary way of making a "graduating application." I also stated, as I remember it, that a "service stop" could be made by a series of "graduating applications," and also that a "service stop" was made by a continuous escape and reduction of main air or train pipe pressure, which would cause the piston G to become seated against the packing A^2, and that when a "service stop" was made in this way, there was but very little or any expansion or escape of auxiliary reservoir pressure into the brake-cylinder through the opening in the slide-valve H made by the unseating of the valve e^1, as the slide-valve H was moving across the port or opening C.

I believe I also stated that it was possible to make a "graduating application" by the piston G extending beyond the point
156 where its stem g comes in contact with the stem b^1, but I have no recollection of stating that a "graduating application" was made by causing the piston G to move backward far enough to become seated against the packing A^2.

If I have stated anything farther than this I request counsel to point it out to me.

Defendants' counsel states that to avoid an answer several hours long he will put another question to the witness.

X Int. 86. Assume a train of two cars and an engine, one car having a triple-valve device of patent 220,556, the other car having the modified Boyden triple-valve apparatus indicated in my X Int. 81 and 82, and the train having the ordinary brake-cylinders, auxiliary reservoirs, main reservoir, brake-pipe, and other apparatus for supplying air and enabling the engineer to reduce the train-pipe

pressure at will. Now, with such a train, assume that the engineer reduces the train-pipe pressure sufficiently to cause the piston G of the Westinghouse device and the piston 29 of the Boyden device to seat against their respective packings A^2 and 7. When so seated, will not the main valve H, of the Westinghouse device, open the passage C wide open, and will not the large valve 22, of the Boyden device, open its port to an ample capacity, and will not the auxiliary reservoir air, in both devices, then flow freely and rapidly to the brake-cylinders, both of which will at the time be closed against the escape of said air to the atmosphere?

A. Upon the occurrence, stated in the question, the slide-valve H of the Westinghouse device will open the passage C wide open, as I have several times heretofore stated, and with the modified Boyden triple valve, as I understand the construction of the same to be, upon a like occurrence as stated in the question, the large valve 22 of such modified construction will open its port or passage to an ample capacity, and the auxiliary reservoir pressure or air of both triple valves will then flow freely and rapidly to their corresponding brake-cylinders.

157 X Int. 87. Then, so far as opening an ample flow from the auxiliary reservoir to the brake-cylinder when the triple piston is at the extreme backward limit of its traverse is concerned, and, in respect to this one function, the valve 22 of the modified Boyden device is the mechanical equivalent of the main valve H of the Westinghouse patent No. 220,556; is it not?

A. Without reference to anything else, but simply permitting a free flow of auxiliary reservoir pressure or air to the brake-cylinder, it may, thus broadly considered, be said that the said valve 22 of such modified Boyden triple valve, as I understand the same to be, is the mechanical equivalent of the slide-valve H of patent 220,556.

X Int. 88. Assume the same train referred to in my X Int. 86, and assume that the engineer desires to make a graduating application by a series of movements of the graduating valve. In such case, both pistons, G and 29, would move part way back, far enough to allow air to flow from the auxiliary reservoirs to the brake-cylinders through the respective small passages, to wit: the small passage *c*, *s'*, through the main valve of the Westinghouse device, and the small holes and their connecting passage in the stem 18 of the modified Boyden device, and the main valve H of the Westinghouse device would not pass wholly by and uncover the passage C, and the large valve 22 of the Boyden device would not unseat and open its ample port; am I not correct?

A. I believe that you are.

X Int. 89. In making a graduating application in the manner aforesaid, the auxiliary reservoir air passes through the main valve H of the Westinghouse device, and, in the Boyden modified device, the auxiliary reservoir air passes through the large valve 22. Is not this the fact?

A. I believe that it is.

POOR COPY

Adjourned to meet at same place tomorrow, Tuesday, July 28th, 1891, at 10 o'clock a. m.

R. H. WHITTLESEY,
Special Examiner.

158

JULY 28, 1891.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of the witness, HENRY F. NEWBURY, continued:

X Int. 90. Still referring to the supposed train of an engine and two cars, one car equipped with the triple-valve apparatus of the Westinghouse patent No. 220,556, and the other equipped with the modified Boyden apparatus, suppose, now, we plug up the passage *c, s'* of the Westinghouse valve, and also plug up the small holes or their connecting passage in the stem 18 of the modified Boyden apparatus. Then, will not the operation of said two triple valves be substantially as follows:

The Westinghouse valve, in making a service stop, will effect it by means of the main valve H uncovering in whole or in part the port or passage C; the modified Boyden apparatus, in making a service stop, will effect it by means of the large valve 22 opening more or less the port connected with it; if either valve is capable, when said small holes are thus plugged up, of making a graduating application, then the Westinghouse valve will effect such application by means of its large valve H, and the modified Boyden apparatus will effect such application by means of its large valve 22. I do not ask how said valves, as thus modified, will perform their other functions, but simply with reference to their performance of these two functions of making a graduating application and a service stop. Is not my statement of their operations, respectively, correct?

A. I believe it is.

X Int. 91. One question more with regard to the modified Boyden triple valve, with the small holes in stem 18 assumed to be plugged; would not the operation of such modified triple valve, with its small holes so plugged, be substantially the same as that of the triple valve shown in the patent of Geo. Westinghouse, Jr.,
159 dated January 11, 1876, No. 172,064—I mean the operation of the two triple valves assumed in the question, with respect to the application of the brakes, and the way in which the triple valve effects such application?

A. If the question has to do broadly or simply with the fact that the brakes in both cases can be applied, and without reference to the means, I should answer yes.

X Int. 92. I mean substantially this: In the application of the brakes by said two assumed devices respectively, would not that function, which, in the device of the Westinghouse patent No. 172,064, is performed by the slide-valve H, to wit, the function of admitting air from the auxiliary reservoir to the brake-cylinder to

BLEED THROUGH

set the brakes, be performed, in the supposed modified Boyden triple valve, by the action of the large valve 22?

A. So far as concerns simply the admission of auxiliary reservoir pressure to the brake-cylinder, without regard to holding it there so as to apply the brakes, then I should answer yes.

X Int. 93. And, in the modified Boyden apparatus, further modified as assumed in my few last preceding questions of this morning, the large valve 22, which would perform the function of admitting air from the auxiliary reservoir to the brake-cylinder, to set the brakes, the piston 29, with its supposed feeding groove, the stem 18 connecting the valve 22 to said piston, and the valve 17 for preventing the escape of air from the brake-cylinder during the application of the brakes, and afterwards permitting such escape to release the brakes, would, together, and in connection with the casing, constitute what is known in the air-brake art as a "triple valve;" would they not?

A. It would.

X Int. 94. In such a triple-valve apparatus, the valve 22 would be absolutely essential to the operation of the apparatus as a triple valve, and if said valve 22 were removed, the apparatus would cease to have any practical or useful function, would it not?

160 A. I do not at the present moment think of any situation wherein the modified Boyden structure referred to in the few preceding questions would serve any useful function when the valve 22 was removed, as stated in the last preceding question, although there may be situations where it would. It would not, in my opinion, be capable of serving the functions of a "triple valve."

X Int. 95. Now, assuming the triple valve of plate XI of the Boyden 1891 catalogue, modified simply as stated in X Ints. 81 and 82, and without the small hole in the stem being plugged, you have already testified that such structure would perform the functions of an ordinary "triple valve," but would not be a "quick-action triple valve." If, now, we should simply remove the fastening which is assumed to confine the check-valve 26 to its seat, then, thereupon and without anything further being done to the apparatus, said apparatus would become and be a "quick-action triple valve," would it not?

A. As I understand the present assumed construction, it differs only from the "quick-action triple valve" illustrated in plate XI in that additional means, viz., what is termed in patent 360,070 the "feeding groove 51," is added for the purpose of permitting main air or train pipe pressure to enter the auxiliary reservoir and restore the pressure therein to the desired limit, after such pressure has escaped from the auxiliary reservoir to the brake-cylinder, in applying the brakes or otherwise.

This additional means has only to do with the charging of the auxiliary reservoir and that alone, and this would not affect the operation of the balance of the apparatus in any way, shape or manner, except that the pressure in the auxiliary reservoir would be somewhat higher, when the "feeding groove 51" was added, than it would be when the auxiliary reservoir was fed or charged through

the check-valve 26 alone, and, therefore, the equalized pressure between the brake-cylinder and the auxiliary reservoir in ap-
161 plying the brakes with the maximum force of such reservoir would be slightly higher with the modified construction set forth in the question, than it would be when a structure precisely like that of defendants' 1891 catalogue was used.

From the above it is manifest that the modified Boyden "triple valve," as set forth in the present question, would be as much a "quick-action triple valve" as is the one shown in plate XI of defendants' 1891 catalogue.

X Int. 96. The gist of my question was this, to wit: that the simple removal of the fastening which was assumed to bind the check-valve 26 to its seat, would change the apparatus from a plain "triple valve" to a "quick-action triple." This is the fact, is it not?

A. The reopening of the passage by means of which main air or train pipe pressure can be directly admitted to the brake-cylinder by the removal of the obstruction which before closed it, namely, the check-valve 26 and the brazing which held it rigidly, and made it become a portion of the casing itself, and the resupplying of such reopened passage with a check-valve and its necessary seat and packing, which necessarily were destroyed in the brazing operation, would reconstruct the said modified Boyden triple valve, and restore it to practically its former construction, mode of operation and functions.

Simply taking the entire apparatus apart and putting the casing in the furnace, and reheating it to the extent necessary to melt the metal used in the brazing operation, and doing no more, which would be simply removing the means which fastened said check-valve to the casing and made it a portion of such casing, would not render the apparatus of any value as a "triple valve" or a "quick-action triple valve." In order to render such a mechanism capable of performing the functions of either a "triple valve" or a "quick-action triple valve," it would be necessary to reconstruct it as I have set forth.

X Int. 97. Brazing, however, was suggested by me only as one practical means of fastening the check-valve to its seat. As
162 another means, the check-valve might be pinned to its seat, or the space between the check-valve 26 and the block 25 might be filled with a block or blocks of wood or other hard material, so as to prevent the check-valve from lifting from its seat. Assuming the check-valve to have been confined to its seat by pinning it thereto, or by putting a block of metal between it and block 25, large enough to extend from the check-valve to block 25, then the simple removal of such fastening would change the structure from a plain "triple valve" to a "quick-action triple valve," would it not?

A. In either of the cases suggested you have to go farther than "simple removal." You have to restore or reconstruct the several parts of the passage by means of which the direct admission of main air or train pipe pressure can take place to the brake-cylinder. And if the term "simple removal of such fastening" means such restora-

tion or reorganization, then I should answer yes; that such restoring or reorganizing of such passage, and providing the same with the check-valve 26 operating as shown in plate XI, did change the said modified Boyden structure from a "triple valve," capable of performing only the first two classes of work heretofore referred to by me, into a "quick-action triple valve," capable of performing all three classes of work heretofore referred to by me.

X Int. 98. All that would be necessary to change the supposed structure from a plain "triple valve" to a "quick-action triple valve" would be to remove the triple valve from its casing, take it apart, remove the fastening pin or block that held the check-valve to its seat, then put the parts together just as they were before the fastening pin or block was inserted, and restore them to the casing; am I not correct?

A. Not entirely. You might or you might not be, according to circumstances not stated in the question.

X Int. 99. What do you mean by that?

A. I mean that, in all probability, you would have to plug up the holes made by your fastening pin, and restore the parts to their original condition.

163 X Int. 100. My question assumed them to be restored to their original condition; and, with this understanding, I request you to give a simple, direct answer to the question, without any further evasion or quibbling. You know exactly what I mean by my question, and you are capable of giving a fair answer to it, if you will only endeavor to do so.

Witness states that he has given a fair answer to every question propounded to him by counsel for defendants, and that when counsel states that the witness knows what he (counsel) means, that he is assuming that witness is aware of what exists in counsel's mind alone, as witness thinks the last few questions and answers, as well as many which have preceded them throughout this examination, will clearly show.

By turning to X Int. 100, the present one, it will be observed that counsel states: "My question assumed them to be restored to their original condition," which is just what witness assumed the question to mean, although it did not state it in terms, and he restored them, that is, the several parts, in witness' answer to the questions from Int. 95 to 97 inclusive, and answered the questions fully and fairly.

A. The present question for the first time states what counsel means by "simple removal," which is the same meaning I had heretofore stated that I placed upon the term, and answered the question accordingly. With this understanding, upon which we are now agreed as it appears, I will say that the said modified Boyden structure, by such "simple removal" or restoration would become capable of performing the functions of a "quick-action triple valve," and that such "simple removal" or "restoration" would give to such structure the capacity for performing the third class of

work, which distinguishes a "triple valve" from a "quick-action triple valve."

X Int. 101. Then it would thereby be changed from a
164 plain "triple valve" to a "quick-action triple valve," would it not? Please give me, for once, a direct answer, yes or no, to a simple, square question which properly admits of no other answer.

A. It would, as I have repeatedly stated.

X Int. 102. We will now drop the modification of the Boyden structure shown in plate XI, and refer to the structure as it is illustrated in said plate. In that plate I find an annular part around the enlarged and hollow stem of the triple-valve piston, just above the piston itself, and marked 9 on said plate. On page 29 of the Boyden 1891 catalogue said part 9 is termed a "sleeve bushing." What do you understand to be the function of that part and its passage B in the operation of the Boyden quick-action triple valve?

A. One of the functions of such part I understand to be providing the casing or chest with a metal which will wear smoother and to a less extent by the repeated movements of the piston stem back and forth through it than the metal of which the main portion of the casing or chest is composed. Another function is to more readily provide a bearing of the proper length for the triple-valve piston than would be the case if the bearing was constructed upon and intergal with the main body or portion of the casing or chest.

This "sleeve bushing" 9 does not have the passage B constructed in it, but the passage B is constructed in the main portion or body of the casing or chest, as clearly appears upon said plate XI of defendants' 1891 catalogue.

I have not the slightest objection to stating what my understanding of the function in the construction, as above stated, of the port or passage B is, if counsel desires it.

X Int. 103. Have you stated all the functions of the sleeve bushing?

A. I have the special functions. Of course, there is the general function of closing up the space between the piston stem and the main portion or body of the casing or chest to the extent possible, and yet have such piston stem move back and forth through it
165 freely, and form a portion of the casing or chest in which the piston chamber D is constructed, and thus forming a portion of such chamber. I believe the above are all the functions of the sleeve bushing 9.

X Int. 104. If said space were left open and unobstructed, and having a capacity as large as, or larger than, the passage A leading from the auxiliary reservoir, would the apparatus perform the functions of a "quick-action triple valve"?

A. Probably not, although it is not definite what the size of the passage A is relatively to the port or opening made by the unseating of the auxiliary valve 22 to its extreme extent and the passages which I have marked upon said plate XI *h*, *h*.

It would depend upon the relative sizes of these several passages whether the pressure in the chamber C was reduced considerably

below the pressure in the auxiliary reservoir, and also that in the main air or train pipe.

It will be remembered that in my direct examination I explained at length the operation of said Exhibit "Defendants' Quick-action Triple Valve," as illustrated in said plate XI of said Exhibit Defendants' 1891 Catalogue, as well as the underlying principles of "quick action."

Defendants' counsel objects to this answer being continued any further with needless explanations and repetitions, because the question was fully answered by the first two words, "Probably not," and the rest is mere waste of time.

(Answer continued.) If the passage A of said plate was of the thickness of ordinary writing paper, it would show precisely the same as it is shown in said plate XI; and, if this was the case, then, unquestionably, the mechanism shown in such plate would be a "quick-action triple valve," but probably not as good a one as it is now.

166 I mention these facts simply to show that there was nothing definite about the question, and that in the opening part of my answer I assume that the probabilities were that the passage A was of sufficient size to defeat the fundamental or underlying principle of "quick action."

X Int. 105. Referring to the structure illustrated in plate XI of the Boyden 1891 catalogue, if the check-valve 26 and the spring 27 were simply removed therefrom, without making any other change in the structure, such removal would defeat the operation of the device, both for the purposes of a plain "triple valve" and for the purposes of a "quick-action triple valve," would it not?

A. I believe that substantially it would if the passage B leading from the chamber C to the auxiliary reservoir portion of the piston chamber D was sufficiently large to permit auxiliary reservoir pressure to return to the main air or brake pipe as fast as or faster than the pressure in such pipe was reduced. But we have no sufficient data upon which to form an intelligent opinion on this point. It would depend wholly upon the size of the opening B as to whether such removal would or would not defeat the mechanism shown in said plate XI in performing the functions of a "triple valve" or a "quick-action triple valve."

There is no doubt but what it would interfere with the functions to be performed by a "triple valve," or a "quick-action triple valve," but as to the extent of such interference I cannot state, for the reasons heretofore given in this answer.

X Int. 106. Again: Referring to the structure illustrated in plate XI of the Boyden 1891 catalogue, if the large valve 22 were simply removed therefrom, without making any other change in the structure, such removal would defeat the operation of the device, both for the purposes of a plain "triple valve" and for the purposes of a "quick-action triple valve;" would it not?

A. Certainly; the same as the removal of any other part, as the casing or chest, would do.

167 X Int. 107. Referring to the structure illustrated in plat XI of the Boyden 1891 catalogue, if the hole in the stem 1 were plugged up, without making any other change in the structur would such change defeat the operation of the device either for th purpose of a plain "triple valve" or for the purposes of a "quick action triple valve," or would it still be capable of performing th functions of both?

A. It would in an imperfect manner be capable of performin the functions of both, for the simple reason that the first class o work to which I have heretofore referred, viz., making "graduatin applications," would be, in my opinion, very seriously interfere with, if no other changes were made. But I have no doubt tha they could be made after a manner similar to some of the olde forms of "triple valves," where such work was imperfectly performed

X Int. 108. Referring to the structure illustrated in plate XI o the Boyden 1891 catalogue: In making an "emergency" stop with said structure does not the stem 18 pull the valve 22 from its seat before the check-valve 26 becomes unseated, so that, for a moment, what you call the passage leading from the main air pipe or train-pipe to the brake-cylinder is closed, although the valve 22 is open; and does not the reduction of air pressure that then takes place in the valve chamber C, force the check-valve 26 from its seat, and thereby open such passage from the train-pipe to the brake-cylinder?

A. As I described in my direct examination, the collar *m* on the portion 18 of the main valve 17–18 comes in contact with the auxiliary valve 22, and lifts such auxiliary valve off its seat to a certain extent, which extent is sufficient to produce a port or passage of greater capacity than that of the passage B leading from the auxiliary reservoir portion of the piston chamber D into the chamber C, and this is done before the auxiliary valve 22 has opened its port or passage to the full extent. And before it is opened to such extent, I believe that the pressure in the chamber C will expand or
168 escape through the port or passage made by the unseating of the auxiliary valve 22, as before described, into the chamber H, and thence through the passages *h h* into the brake-cylinder, reducing the pressure in said chamber C far below that in the main air or train pipe, which reduction permits the superior force of the main air or train pipe pressure to force the check-valve 26 off from its seat before the auxiliary valve 22 is unseated to its full extent; from which it follows that there is no appreciable time between the unseating of the auxiliary valve 22 and the opening of the said check-valve 26. The reduction of pressure in the chamber C, as before stated, permits the main air or train pipe pressure to force the check-valve off its seat, as described; but said reduction never forces it off; it only permits it to be forced off.

X Int. 109. In making an "emergency" stop with the Boyden "quick-action" apparatus, do not the auxiliary reservoir air and the train-pipe air meet and mingle in the valve chamber C, and both together pass simultaneously through the same port (to wit, the port controlled by the valve 22) to the brake-cylinder?

A. If the ports or openings *i j* and the passage *k* connecting such

ports or openings together were added to the port or passage made by the unseating of the auxiliary valve 22, I should answer yes.

X Int. 110. I was merely asking with reference to what would take place through the large port controlled by the valve 22; and, with that understanding, would you not answer "yes," without any qualification?

A. To a certain extent, I would.

X Int. 111. The great proportion or larger quantity of the commingled reservoir and train-pipe air would pass through the port of the valve 22, would it not?

A. I should expect that it would. I am not prepared to say to what extent the two pressures would commingle in this chamber C before passing into chamber H, for it will be seen that the auxiliary reservoir pressure is greater than that of the main air or train pipe pressure, and also that it is greater than that in
169 the brake-cylinder, which is necessarily below that of the main air or train pipe pressure.

X Int. 112. In the structure shown in the Boyden 1889 catalogue, plate IX, that part which corresponds to the piston stem 18 of plate XI in the Boyden 1891 catalogue is cut in two or made in two separate pieces, is it not?

A. It is, as I stated in my direct examination; that is, the parts corresponding with the main valve 17, 18, of the said "Exhibit Defendants' Quick-action Triple Valve," as illustrated in plate XI of said "Exhibit Defendants' 1891 Catalogue," is, in the structure shown in plate IX of said "Exhibit Defendants' 1889 Catalogue," made in two parts.

I do not know to just what portion or to what extent the said main valve 17–18, as the same is shown in said "Exhibit Defendants' 1891 Catalogue," is used to make up the "stem 18" of the present question. I would naturally understand that it was made up of that portion of the main valve 17–18, between the so-called "leather cup" 17 and the valve portion, made up of the ports or openings *j*, *i*, and the passage *k*, connecting the same. If such is the meaning of the question, then the part which corresponds with such "stem 18" would be in one piece only, and not in two pieces.

X Int. 113. In plate IX of defendants' 1889 catalogue the division line between the two parts referred to is indicated by the transverse line across the stem, between the figures 13 and 17, where the section lines of the drawing take opposite inclinations, is it not?

A. That depends upon what the present question means. If it is the division line between the two parts of the main valve 17–18, I would answer yes; but if it is between the two parts of the "stem 18" I should answer that it was the line showing where the corresponding stem in said "Exhibit Defendants' 1889 Catalogue" ended, and not a division between two of its parts.

Defendants' counsel states that this is mere verbal criticism of the question, and that he has not time to wait for it, but will pro-
170 ceed with another question.

(Witness continues:) The part marked 13 of said plate IX of said defendants' 1889 catalogue on page 24 thereof is called the "graduating valve," and the part on the same plate designated 17 is called "release-valve stem."

X Int. 114. The fact that in the structure of plate IX of the Boyden 1889 catalogue the release valve and its stem are separate from or not integral with the part marked 13 on said plate, does not prevent the release valve from being a part of the triple valve, does it?

A. No.

Defendants' counsel states that, having gotten one direct, categorical answer to a question, he now closes the cross-examination.

HENRY F. NEWBURY.

Adjourned to meet upon agreement of counsel.

171 United States Circuit Court, District of Maryland.

GEORGE WESTINGHOUSE, JR., *et al.* *vs.* BOYDEN POWER BRAKE COMPANY *et al.*	In Equity. No. 321.

It is hereby stipulated and agreed that H. Herman Westinghouse and Henry B. Stone would, if called and sworn in this cause, testify as they have testified in the accompanying printed copy, which is identified by the signatures of counsel, and that their depositions as printed in said copy may be used and read at the hearing with the same force and effect as if taken in this cause.

It is further stipulated and agreed that either or both of said witnesses shall, if desired by counsel for defendants, be produced for cross-examination at such time as may be agreed upon by counsel, it being understood and agreed that H. Herman Westinghouse shall attend for cross-examination either at Chicago or Baltimore, as may be hereafter determined by counsel for defendants, and that Henry B. Stone shall attend for cross-examination at Chicago. Waiver of cross-examination by counsel for defendants shall not operate to affect the admissibility of the deposition or depositions in chief.

New York, January 18, 1891.

GEO. H. CHRISTY,
J. SNOWDEN BELL,
For Complainants.
LYSANDER HILL,
Of Counsel for Defendants.

172 H. HERMAN WESTINGHOUSE, a witness produced on behalf of complainants, having been duly sworn, deposes and says in answer to interrogatories propounded to him by J. Snowden Bell, Esq., of counsel for complainants, as follows, to wit:

38 Q. What is your name, age, residence and occupation?

A. My name is H. Herman Westinghouse; age, thirty-eight years; residence, Pittsburgh, Penn.; I am general manager of the Westinghouse Air Brake Company of Pittsburgh, Penn.

39 Q. For how long have you been connected with the said company?

A. Since the year 1872.

40 Q. To what extent have you become familiar with the construction and operation of fluid-pressure brake mechanism for railroads?

A. My experience has been such as to make me entirely familiar with their construction and operation. My first employment in connection with the Westinghouse Air Brake Company was in their foundry, afterwards in their machine shops, and then in their draughting and designing department. I was subsequently engaged in the application and operation of brakes to railway trains in service, and I then became general agent of the company for the introduction and sale of their apparatus. I am familiar with all the experiments and trials that led to the development of improvements, and in the winter of 1887 was made general manager of the Westinghouse Air Brake Company.

41 Q. Will you please explain what is meant by the term "quick-action automatic brake," as that term is understood and applied in practice, relatively to what are ordinarily known as "automatic brakes."

A. "Automatic brakes," as generally used upon trains of considerable length, perform all of the usual operations of braking, for what are known as "service stops," in an entirely satisfactory manner. By "service" stops I mean such as are usually
173 employed in operating trains in transacting the regular business of railroads—in contradistinction to those stops which are called "emergency stops." By "emergency" stops I mean those that require trains to be stopped as quickly as possible, to prevent accident or disaster.

To render the operation of brakes, in "service" stopping, satisfactory and economical, the result of practice has determined that the amount of braking power should be limited to a degree that will render it possible to operate the brakes without reasonable liability of locking the car wheels when in motion. Such a result is objectionable, as by means of it flat spots are worn in the periphery of the wheels and they are rendered unfit for further service.

In the operation of automatic brakes for "emergency" purposes, on trains of considerable length, their application is necessarily retarded to a considerable degree, and this feature, combined with a necessary limitation of power, as heretofore explained, causes the

stopping effect to be considerably less than the maximum theoretic-ally obtainable result.

The construction of "quick-action" automatic brakes is such a to provide for all of the requirements of "service" stopping, equall as well as those functions have heretofore been performed by th "automatic" brake system, and they are additionally arranged s that when "emergency stops" are made, there is practically no dela in the full application of the brakes, and there is also a considerabl augmentation of power, as compared with that available in "service applications.

The features of substantially instantaneous action and augmented power in "emergency" applications, constitute the distinguishing features of the "quick-action" automatic brake as compared witl the ordinary "automatic" brake.

42 Q. Will you explain by what means or appliances, other than or different from those employed in "automatic" brakes, the func-tion of more rapid and powerful application which you have men-tioned is attained in "quick-action automatic" brakes?

A. The improved operation heretofore described is obtained
174 by an addition to the mechanism of the triple valve, which
causes the prompt and more powerful application of the
brakes in "emergency stops."

43 Q. By what term is a triple valve, provided with the addition mentioned in your last answer, designated in the art?

A. It is called a "quick-action triple valve."

44 Q. Please examine Complainants' Exhibit "Complainants' Catalogue" and indicate such illustration or illustrations therein as correctly represent "quick-action triple valves" manufactured by the Westinghouse Air Brake Company and furnished to railroads by such company?

A. The illustration of the "quick-action triple valve" is found in "complainants' catalogue" on plates D^1, D^{22}, D^{26} and D^{31}. On plate D^1 the "quick-action triple valve" is represented on the left side of the plate, and is represented as attached to a brake-cylinder designated "10-inch brake-cylinder."

45 Q. Will you state approximately to what extent "quick-action triple valves" substantially similar to those illustrated as stated in your last answer, have been manufactured by the Westinghouse Air Brake Company and furnished by them to railroad companies?

A. They have been furnished substantially to the exclusion of all other forms since December, 1887, and there are now about 125,000 in general use.

From an extended knowledge of their performance they are re-garded as giving entire general satisfaction.

46 Q. When and by whom, so far as your knowledge and infor-mation extend, were "quick-action automatic brakes" originated and introduced into practical railroad service?

A. They were invented some time during the year 1886 by George Westinghouse, Jr., and were practically introduced by the West-inghouse Air Brake Company, of which he is president, during the year 1887.

47 Q. Please state the circumstances which led to the introduction of "quick-action automatic brakes" into practical railroad service, and the results which have been attained by their use therein?

175 A. In 1885 the Master Car Builders' Association, an organization composed of those having charge of the construction and maintenance of car equipment upon railroads in the United States and Canada, and also of those engaged in the manufacture of cars for sale, appointed a committee to investigate the relative merits of several brakes that were represented by their owners as suitable for general use upon freight cars. After obtaining such information as was available, this committee reported to their association that the subject was of such importance that information necessary to enable them to form a conclusive judgment was not available, without the aid of experiments or tests of the different forms of brakes under conditions that would fairly represent the average practice of railroads.

This report led to a series of tests, conducted under the supervision of the committee of the Master Car Builders' Association, in which the several makers of car-brakes were requested to participate. The committee selected a train of fifty freight cars, as in their judgment representing the longest average train practical in general service, and the different brake manufacturers were required to furnish brakes to operate upon trains of this length. Provision was made to have the tests comprehend all of the functions that could reasonably be expected of the brake apparatus, with a view to making the results as comprehensive as possible, thereby making it possible for those interested in the use of power brakes to purchase apparatus that would render satisfactory service.

Provision was also made for what were called "endurance" tests, it being the intention of the committee to place in general service (after the trials had taken place) the brakes which had been offered for trial. The object in view was to ascertain, after a stated period, the extent to which the efficiency of the brake apparatus had been impaired by use.

The tests were formally opened July 13, 1886, and continued without interruption till August 3. Five different forms of apparatus were tried as far as possible under the prescribed con-
176 ditions. The Westinghouse Air Brake Company furnished fifty sets of their standard automatic freight-brake apparatus, and they were identical with about 50,000 sets that had already been furnished by them for use upon roads located principally west of the Missouri river. This form of brake gave satisfactory service where it had been used. The roads adopting it had extremely heavy grades and the length of train was necessarily limited, and, therefore, the absence of the quick-action element was of less consequence than if trains of greater length had been generally possible.

The fact that maximum efficiency in train-stopping was not realized in "emergency" cases was not generally commented upon,

probably for the reason that the results arrived at were much superior to anything that had been theretofore attained.

The committee in their report upon these trials make the following statements, which I quote from the report of the proceedings of the Master Car Builders' Association, June, 1887, pp. 112, 113:

"The results of these 1886 tests were disappointing. None of the competitors, in the estimation of your committee, did satisfactory work, owing to the violent shocks produced in stopping. Slack in long trains controlled with power brakes applied successively from the engine, assumed at once a most prominent part in this and, doubtless, all future contests. The expected delays in discharging and releasing continuous brakes were shown to be of no moment, and while the objections of successive application was developed to an extent calling for the most serious consideration.

* * * * * * *

"Your committee's work, as laid out at the Harrisburg meeting of January 6, 1886, had in contemplation an endurance test of nine months' regular service. The contest, however, had developed so many points where improvements might be made, that at a meeting held in New York, in the month of September following
177 the 1886 contest, it was decided to abandon the endurance test and its restrictions."

While the fact was well known that automatic brakes are necessarily applied successively, that is to say, one after another instead of simultaneously, these tests were the first practical demonstration that the interval of time between the applications of the brakes upon the several cars could be so great as to become a dangerous and objectionable element of operation of brakes on long trains and in making "emergency" applications. As shown by the report of the committee, when the brakes were applied with full force to the front portion of the train, and before movement could be communicated to those upon the rear portion, the front of the train would be retarded sufficiently to produce a collision between it and the part of the train upon which the brakes were not yet in full operation. The opportunity for such action is, of course, brought about by the lost motion or "slack" that becomes necessary in coupling cars together, and providing for the necessary motion of the springs of the draft rigging.

Stated in reasonably exact terms, in a train of fifty cars there is usually not less than twenty-five feet of lost motion, and this is generally exceeded.

The degree of this collision or shock was determined by a registering device called a "slideometer." The following quotation from the committee's report (p. 84) will explain its construction and operation. It also states the amount of shock which the committee considered inadmissible in general service:

"The device consists of a wooden trough, 14 feet long by 6 inches wide, made of clear white pine, smoothly planed. This trough is screwed fast to the centre of the rear car. In the trough slides, in either direction, a wrought-iron weight 5 inches in diameter and 3

inches high, weighing 16¼ pounds. Crude as the device may appear, it has answered its purpose perfectly, registering all the
178 various demands made by the competitors. Whether a violent shock forward, of from 50 to 150 inches, a jerk backwards, or a succession of rapid forward and backward movements, the slideometer always told the story, and doubtless met the different demands on it much better than more elaborate devices which might have been prepared could the importance of some such gauge been foreseen. Its simplicity adds to its value, as it could be readily produced in any locality for testing purposes, or drilling men in handling long trains, etc. Shocks, in ordinary handling of trains with slack couplings, over sags, hogbacks, and working in yards, will move the disk from 2 to 8 inches; 12 inches has been estimated as sufficient to be injurious to live stock and equipment. Repeated blows of from 12 to 20 inches, in the mixed and loaded car test, were sufficient to start the loads at the rear end of the train, through the ends of the cars; the loaded cars thus, through the movement of their loads, becoming a check in weighing the length of the slideometer movement that was admissible and inadmissible."

The maximum shocks developed by these tests are stated in the committee's report on page 96, from which the following quotation is made:

"The horizontal lines show the speed in miles per hour, while the vertical lines show the time at five-second intervals. The figures show the time in minutes. Allowing thirty seconds to reduce the speed to fifteen miles an hour, the run should have occupied about seven and one-half minutes. The diagrams show very plainly great room for improvement in both the Eames and the Westinghouse brakes, and, were it not for the low speed, would apparently give the award to the American Brake Company, for, up to nine minutes, it will be observed, the speed is uniformly maintained between eight and ten miles per hour. This record, however,
179 it should be borne in mind, was taken in the autographic car placed in the middle of the train. While the persons riding in this car and the dynamometer car were commenting upon the uniformity of the run that was being made, although somewhat below the fifteen-mile speed, an entirely different record was being registered in the rear or 52d car. Here shock after shock was being received, their rapid succession adding to their intensity. Twenty-eight blows, of more or less severity, were given during the run of eleven and one-half minutes, culminating in a shock of sixty-three inches, which broke the train in two. An examination of the train after the stop revealed the fact that nine of the rear cars had their ends broken and bulged out, by the shifting of the loads, to such an extent that they were in a dangerous condition, and this, notwithstanding the fact that the wheels with which the cars were loaded had been stowed with special care, and the ends of the car blocked with timber. This test was more instructive than any other could possibly have been, in showing the inherent weakness of brakes actuated by independent pulsations or blows transmitted through the draft springs. The second is all the more prominent,

as, notwithstanding the shock-producing powers developed by the continuous brakes in fifty-car train stop, their down-grade runs were comparatively free from shocks."

With the train fitted with the Westinghouse automatic brake the maximum shock was forty-nine inches on "emergency" application.

An examination of this report will reveal the demonstration of the fact heretofore stated that it is only in "emergency" applications that the objectionable features described were developed, and careful investigation readily reveals the cause for different action in the two methods of application of the brakes.

Automatic brakes as constructed require the location upon
180 each car of a cylinder with a piston for bringing brake-shoes into
contact with and releasing them from the wheels; a storage reservoir, known as an "auxiliary reservoir," for holding a supply of air under pressure for the purpose of operating the piston of the brake-cylinder when the brakes are to be applied, and a valve mechanism known as a "triple valve," which controls the supply of air to the auxiliary reservoir, also from the auxiliary reservoir to the brake-cylinder, and finally when the brakes are to be released from the brake-cylinder to the atmosphere. The supply of air for the auxiliary reservoir is obtained by a line of pipes with flexible hose and couplings extending from car to car which is called a "train-pipe;" and this "train-pipe" is connected on the locomotive to a main storage reservoir, to which compressed air is supplied by a pumping mechanism.

The movement of the "triple-valve" mechanism is the means of permitting the compressed air stored in the auxiliary reservoir to pass into the brake-cylinder for the purpose of causing the brakes to be applied.

The normal condition of the automatic brake system when ready for use, but when the brakes are not being actually operated, requires a uniform pressure of compressed air in the train-pipe, triple valve and auxiliary reservoir. To cause the mechanism of the triple valve to operate so that the brakes may be applied, it is necessary that the air pressure in the train-pipe be reduced to a greater or less degree, depending upon the force with which it is desired to apply the brakes. This is done by means of an operating valve or cock, called, ordinarily, an "engineer's valve," located upon the locomotive, by means of which communication is first closed between the main air reservoir and the train-pipe, and an opening is effected from the train-pipe to the atmosphere.

From the foregoing explanation, it will be clear that the triple valves in a train of cars will operate when there is a reduction of pressure in the train-pipe contiguous to the triple valves; and if for any reason the reduction of pressure is not uniform or iden-
tical throughout the train-pipe, it is manifest that there will
181 be a lack of uniformity in the application of the triple valves,
and consequently in the time of application of the brakes.

It has been experimentally determined that in a train-pipe of the extreme length used in general practice, a moderate-sized opening

› the atmosphere may be made in one end, by means of which a ıbstantially uniform reduction of pressure will be made through ıe entire length of the train-pipe. If, however, a considerable pening is made to the atmosphere, thereby effecting a great reduc- on of pressure at one end of the train-pipe, the friction of the ompressed air moving through the train-pipe will retard its flow, ausing a considerable reduction of pressure in the vicinity of the pening, as compared with that at the opposite end of the train- ipe.

As heretofore explained, the degree of force with which the brakes re applied depends upon the reduction of pressure made in the ain-pipe. It is, therefore, clear that when the moderate and uni- rm reduction of pressure required for a "service" stop is made, ıe movements of the several triple valves will be substantially multaneous upon all the cars of the train, and the action of the akes will be in accordance therewith. This produces a uniform tardation of each car in the train, and does not create or cause a ndency in the different portions of the train to change their rela- ons to each other.

When, however, it becomes desirable or important that the brakes ould be applied with the greatest possible force, it is necessary at the train-pipe pressure be reduced as rapidly as possible; and the "automatic" system of brakes this is accomplished by open- g a communication between the train-pipe and the atmosphere of e greatest practicable size. In doing this there is necessarily a uch greater reduction of pressure in the immediate vicinity of the ening in the train-pipe, for a period of time, depending upon the igth of the pipe, compared with what takes place in portions of the train-pipe more remote from the discharge opening. The
2 effect of this uneven reduction of pressure in the train-pipe is to cause those triple valves so located as to be operated by e earlier and greater reduction of pressure, to apply their brakes icker and temporarily with greater force than those valves more stant from the opening. Brakes are, therefore, applied upon those rs more favorably located, relatively earlier and with greater force an those in other portions of the train; and the motion of their rs is arrested to a greater degree. The portions of the train in iich the speed has not been equally reduced move forward the ıount of slack motion that exists in the train, until they come o contact or collision with those portions upon which the brakes ve been applied more promptly and with greater force, owing to reasons already explained.

The decree of shock or collision will depend upon the differences degree and time of application of the brakes upon different por- ns of the train. In the design of automatic brakes it was con- ered desirable for constructive reasons to limit the size of the ssages in the triple valve making communication between the xiliary reservoir and brake-cylinders; and for this reason a period about three seconds was required to obtain the maximum brake- ce from the time that the triple-valve mechanism commenced to nit air from the auxiliary reservoir to the brake-cylinder. This

is, however, a characteristic of all triple valves of this type, and does not affect their periods of operation relatively to each other.

The report of the committee of the Master Car Builders' Association upon the results of these trials has heretofore been quoted from. While they did not find that any of the competing brakes met the prescribed conditions, for the purpose of comparison with future trials it is important to state the observed facts in reasonably exact terms.

Taking the train of the Westinghouse Air Brake Company as representing the best average performance, it will be found that an average distance of 350 feet and a period of seventeen sec-
183 onds was required in which to stop a train of fifty empty cars running on a level track at a speed of twenty miles per hour, and that it required an average of twelve seconds to fully apply the last brakes on the fifty-car train. These deductions are made from information to be found in plates 9, 10, 11, 12 and 13, series A, 1886, of the Master Car Builders' Association's Report for 1887.

As these trials were the first attempt to operate brakes upon trains of great length, it was only at this time that the inability of the automatic brake to meet every practical requirement of freight-train breaking was developed, and the importance of the investigation to those who desired to make use of power brakes on freight trains can scarcely be overestimated. As bearing upon this point I refer to page 76 of the Report of the Master Car Builders' Association for 1885, in which it is stated that the committee found in actual service more than 2,800 of what was called the American buffer brake. This device, while having acknowledged limitations, had made very satisfactory demonstrations upon trains of fifteen or twenty cars, and as its first cost was comparatively low, considerable headway had been made, as found by the committee, in introducing it. At the trials at Burlington in 1886, when an attempt was made to operate it upon a train of fifty cars, the results were so disastrous as to seriously injure several of the cars of the train. After this exhibition no further attempt was made by the owners of this device to extend its use, as it was clearly demonstrated that all previous expenditures made by those purchasing the apparatus was a complete loss.

An examination of the results obtained led George Westinghouse, Jr., to make investigations with a view to so changing the form of brake apparatus as to have the effect of operating with a less interval of time between the apparatus on the several cars, and also, if possible, provide for a greater available force, so as to arrest the motion of the train in a less distance than had been done at the 1886 Burlington trials. The functions of graduated or
184 "service" stopping being already satisfactorily performed, it was highly desirable that these should not be interfered with; and experiments were therefore directed to obtaining the same uniformity of action, as nearly as possible, as existed in the service operations of the apparatus.

That absolute coincidence of operation is not required was amply

demonstrated by the performance of many thousand brakes upon short trains. Such difference as exists in the times of operation of the different valves, as heretofore explained, had not up to the time of the Burlington tests been of a sufficient degree as to be a source of unfavorable comment by those having the brakes in operation, owing to the fact that experience had been limited to short trains, upon which the objectionable action does not take place.

To enable experimental work to be reliable in judging results, the conditions that existed in a train of fifty cars were duplicated as far as possible. Fifty complete sets of brake apparatus for cars were arranged in close proximity to each other, so that their operation could be readily observed, and these were connected together by the proper length of train-pipe, with the usual hose couplings and cocks required in actual service, the length of the train-pipe being equal to that required for a fifty-car train. This apparatus was erected in the works of the Westinghouse Air Brake Company, and was provided with electrical recording apparatus to accurately determine the relative time of application of the several brake mechanisms. As before stated, it was found that a period of twelve seconds elapsed before the full application of the first and last brake-cylinder, when air was exhausted from one end of the train-pipe, in the usual manner of operating the automatic brake for "emergency" purposes.

By placing in the train-pipe, at regular intervals, a form of delicately adjusted exhaust valve, it was found possible to cause them to operate by the moderate reduction used in "service" applications. The operation of these valves caused air to be exhausted from the
train-pipe, wherever they were located, and, their action
185 being nearly simultaneous, the effect of their operation was
to cause a nearly uniform application of all the brakes, practically coincident with the exhaustion of the air at the forward end of the train-pipe.

The construction and operation of this auxiliary discharge valve was of an extremely delicate nature, to a degree which would render its practical use extremely doubtful. It served, however, to demonstrate the direction of further experiment.

I have heretofore referred to the functions of the triple valve, by which air is conveyed from the train-pipe to the auxiliary reservoir, then from the auxiliary reservoir to the brake-cylinder, with a greater or less degree of force as circumstances require, and finally from the brake-cylinder to the atmosphere for the purpose of releasing the brakes. These operations are performed by means of a valve mechanism, controlled by the movements of a piston operated upon by air pressure. And all the operations of supplying the auxiliary reservoir, admitting air to the brake-cylinder of limited pressure, and of discharging the air from the brake-cylinder for the purpose of release, are performed by a partial movement of the piston and valve mechanism of the triple valve. It is only for "emergency" applications or quick stops that the final and complete movement of this piston and valve is required. This final movement is obtained by a rapid and considerable reduction of pressure

in the train-pipe, as compared with what is required for "service" operations.

Advantage was taken of these conditions to arrange an auxiliary-valve device controlling communication between the brake-pipe and the atmosphere, which was caused to operate by the final or complete travel of the piston of the triple valve when a considerable reduction of pressure was made at one end of the train-pipe for emergency or quick stops. With the aid of this device there was a complete exhaustion of the air from the train-pipe at each triple valve, which accelerated the operation of the brakes to a degree that reduced the time of full application on the last car from twelve seconds to six seconds.

186 From the operations as previously described it is plain that in the process of applying brakes the air that was necessarily exhausted from the train-pipe to cause their application was wasted—at least it performed no other service than that of moving the valve and piston of the triple valve; and this was equally true of the automatic brake system and of the auxiliary-valve device just described. The discharge port from the auxiliary valve was therefore connected with the brake-cylinder, instead of leading it to the atmosphere. The effect of this modification was to cause a considerable amount of the pressure in the train-pipe to pass into the brake-cylinder, where it contributed to that regularly supplied by the auxiliary reservoir, augmenting the brake force fully twenty per cent. in emergency or quick applications.

The value of this modification will be better appreciated by referring to that portion of my testimony in which is explained the necessity for a limitation of the braking power in "service" applications. In fact, theoretical considerations would suggest two independent brakes of different degrees of power or force; one of them to be used for "service" operations, to be limited in power to a point that would render the locking of car wheels impossible; the other to be used only in "emergency" or quick stops, and calculated to exert a much greater force, thereby overcoming the speed of the train in the least possible time and distance. With these considerations thoroughly understood, the value of the invention of the auxiliary-valve device for exhausting the train-pipe pressure into the brake-cylinder for emergency applications is made clearly evident.

Another feature of material importance was the fact that these improvements were made without in the slightest degree, interfering with the operation of the triple valve in respect to the important duties it already satisfactorily performed. Valves of the new construction were used in connection and in common with those of the automatic system, and the change did not in any sense impair the value of what had previously been furnished.

187 Provision was made whereby the benefits of the improvement were applicable to the automatic apparatus already in use. This was accomplished by a form of valve mechanism entirely independent of the triple valve of the automatic system, and arranged to control communication between the brake-pipe and

the brake-cylinder. The construction of this valve was such as to cause it to remain inactive or inoperative when a moderate reduction of pressure was made in the train-pipe. When, however, a sudden or considerable reduction was made, the valve mechanism operated and opened communication between the train or brake pipe and the brake-cylinder, producing a result identical with that of the improved or "quick-action" type of triple valve.

The experiments and improvements and changes above described were carried on by the suggestion and under the direction of George Westinghouse, Jr.

The possibility of constructing an air brake in which the actuating valve should be controlled by electricity seems to have been first conceived by George Westinghouse, Jr., as he took out a patent for such a combination. It has since expired. It was not felt that the attainable benefits by the use of electricity would compensate for the many unreliable qualities of such a method of operating valves. The experience of the 1886 trials, however, conclusively proved that extraordinary means would probably be justified, provided the elements already employed failed to meet the specified requirements of the Master Car Builders' Association.

The 1886 experiments clearly demonstrated the necessity of the coincidence of operation of the several brakes in a train to a greater extent than was realized with any that were tested. By the improvements described in triple-valve construction, the interval of application between the first and last cars of the test train was reduced from twelve to six seconds. Whether or not this improvement was sufficient to overcome the developed objections could only be determined by trial upon a train in actual operation. It
188 was, therefore, deemed advisable to provide an exhaust-valve
mechanism to be operated by electricity, capable of being inserted in the train-pipe as frequently as circumstances proved necessary. Valves of this kind were successfully constructed, and when placed in the brake-pipe were caused to operate so as to exhaust a small quantity of air from the brake-pipe when emergency applications were made. Two of these valve devices, placed at regular intervals in the brake-pipe, were found to be sufficient to produce an instantaneous and uniform application of all the brakes of a fifty-car train.

The important developments made by the 1886 trials naturally led to provisions for similar tests, under practically the same conditions, by the Master Car Builders' Association. Due notice was given to all those interested in the subject, and a period extending from August, 1886, to May, 1887, was given the various competitors in which to make modifications and improvements that were made clearly necessary by the 1886 experiments.

In May of 1887 five companies were represented, all of them furnishing what is known as "continuous" brakes, being the class in which an actuating connection is made from car to car and with the locomotive. Of these, one was operated solely by electricity; one was operated by compressed air alone; and three were operated by a combination of compressed air or atmospheric pressure and elec-

tricity. The apparatus furnished by the Eames Vacuum Brake Company and the Westinghouse Air Brake Company were capable of performing all functions without the aid of electricity. The Carpenter electro-air brake could only be operated by the combined use of air and electricity.

The prescribed experiments were made, and the train of the Westinghouse Air Brake Company was the first subjected to test. In making "emergency" stops without the aid of electrical attachments, the shocks experienced in the preceding year were greatly exceeded, reaching a maximum of 103 inches as compared with the maximum of 49 inches in the 1886 trials. In fact they were so severe
189 that it was not deemed prudent to use the brake in "emergency" applications without the use of the electrical valves heretofore described. When these were used, the desired coincidence of operation was secured and stops were made without perceptible shock.

These results were duplicated in this respect by the other brakes having electrical methods of application.

In the Report of the Master Car Builders' Association (pp. 183, 184) is stated the result of the committee's investigation, which I quote as follows:

"At the conclusion of the 1886 trials, the committee felt that to sum up any results in the face of so large a field for improvement could not but be unsatisfactory, and, while a wonderful advance has been made in the brake problem, as will be seen by a comparison of the stops of each year, the 1887 tests apparently leave the field for improvement open as wide as in 1886. The Widdifield & Button and the Rote buffer brakes, hopeful over the shocks given by the atmospheric brakes, are fitting up or have fitted trains to pursue their investigations; the Westinghouse Brake Company, unwilling to accept as final their May, 1887, record, is making changes in valves and pipings, by which they hope to make short 50-car emergency stops, without objectionable shocks and without the aid of electricity; the American Brake Company, convinced that buffer brakes cannot compete with the continuous, is about testing a 50-car train, fitted with a new electro-atmospheric brake.

"While we are not prepared to make any definite recommendation at this writing as to what freight train brake should be generally adopted, our present information, derived from the recent tests, points to two conclusions:

"First. That the best type of brake for long freight trains is one operated by air and in which the valves are actuated by electricity.

"Second. That this type of brake possesses four distinct advantages:

190 "(*a*.) It stops the train in the shortest possible distance.

"(*b*.) It abolishes shocks and their attending damage to equipment.

"(*c*.) It releases instantaneously.

"(*d*.) It can be graduated perfectly.

"The further question as to whether electricity is a sufficiently

reliable element to use in freight-train service is one that can only be determined by experiment; but, we think, the benefits derived from electricity are so manifest that the experiment is well worth trying. In view of the foregoing and of the improvements that the buffer and atmospheric brakes are making, your committee recommends that the subject of automatic freight-train brakes be continued for further investigation.

"GODFREY W. RHODES,
"BENJ. WELCH,
"GEO. HACKNEY,
"JNO. S. LENTZ,
"W. T. HILDRUP,
"D. H. NEALE,
"*Committee.*"

The beneficial effect of the use of the electric valves was so marked that it apparently seemed to the committee to be the only direction in which to seek for the desired consummation, although it was the expressed opinion of many practical railroad men present that it would be a matter of great regret if necessity required the use of a new and untried agent such as electricity for the successful operation of brakes.

The results obtained with the new "quick-action" valve of the Westinghouse Company were in some respects extremely satisfactory and in others disappointing. The gain in the efficiency or the power to stop a train quickly was beyond expectation, as the average distance required to arrest the motion of a 50-car train running at the rate of 20 miles per hour was but 200 feet, as compared with 350 feet in the 1886 trials. I quote from the committee's 1887
191 report in the proceedings of the Master Car Builders' Association for 1887, as follows (pp. 165, 166):

"By reference to the journal of each day's work it will have been observed that the first four days were occupied by preliminary tests, such as engine tests, hand-brake tests, train-resistance tests, etc. The Westinghouse Brake Company, on the fifth morning of the tests, May 13, commenced the general tests with a 50-car empty train—three stops on level track, with their automatic air brake 50-empty-car train, resulting as follows:

50 Westinghouse Empty-car Train, 1887—Automatic Air Brakes.

No. of stop.	Speed in miles.	Distance in feet.	Shock in inches.	Time in seconds.	Equivalent distance at 20 miles and 40 miles.	
521	19½	186	103	9¾	196	
511	19¼	215	70⅝	11	233	
522	36½	588	70½	17	....	693

"These stops may be regarded as phenomenal in their shortnes which becomes all the more evident when we compare them wit the best results obtained in 1886:

50 Westinghouse Empty-car Train, 1886—Automatic Air Brakes.

No. of stop.	Speed in miles.	Distance in feet.	Shock in inches.	Time in seconds.	Equivalent distance at 20 miles and 40 miles.	
621	23.5	424	Not taken.	17½	307	
611	20.3	354	" " ..	16	340	
622	40	922	" " ..	22½	....	922
612	40	927	" " ..	22¼	....	927

192 "The brilliancy of the record, however, was completely spoiled by the fearful shock given at the rear end, the slideometer moving, it will be observed, from 70 to 103 inches. The same train was then tested electrically, with the following results:

50 Westinghouse Empty-car Train, 1886—Electric Application.

No. of stop.	Speed in miles.	Distance in feet.	Shock in inches.	Time in seconds.	Equivalent distance at 20 miles and 40 miles.	
611	21½	160	None.....	7	139	
531	23	183	"	8	138	
612	38	475	"	14½	....	519
532	36½	460	"	14	....	545

"Now comes the still more astonishing story. In these electrical stops the slideometer never moved, and this with the same cars, the same leverages and the same pressures, the only difference being the time of application. With the shocks the application commenced on the rear car in from five to six seconds; with the electrical application it was practically instantaneous on every car in the train.

"It will, perhaps, be necessary to compare the distances of these stops with other measurements to realize their full significance. Let us take the 138 and 139 feet of the 20-mile stops. Telegraph poles are generally spaced thirty-three to the mile, which allows a fraction of over 160 feet between each pole. The stops were, therefore, made in 22 feet less than the distance between two telegraph poles. Again, each of the Westinghouse cars measured 37 feet 8 inches from face to face of drawbar; 133 feet would therefore be, measuring in freight-car lengths, three car-lengths and 25 feet.

193 The hand-brake stop at the same point with the same cars was made in about five and one-half telegraph poles' length, or a fraction over twenty-three freight-car lengths. This hand-brake efficiency is much greater than generally found in service, on account of the difference in foundation gear."

That the shocks should have been so much greater when the interval between the application of the brakes upon the first and the last car had been reduced to less than six seconds, seemed in a measure paradoxical; but this was explained by the greatly increased efficiency of the brakes in the forward part of the train, as compared with those used in the 1886 trials, and this difference was largely due to the provisions made for realizing the maximum force in the brake-cylinder the instant of the operation of the triple-valve piston. By reference to the preceding portion of the testimony it will be found that a period of fully three seconds was required to obtain full power in this respect with the automatic brakes used in the 1886 trials.

The improvement in respect to the time of application between the first and last brakes was so great between the 1886 and 1887 trials that it was not generally believed by those conversant with the subject who witnessed the tests that a further change sufficiently great could be made to cause the quick-action apparatus to come within the prescribed requirements without the aid of electrical valves. To those, however, connected with the Westinghouse Air Brake Company, the great improvements that had already been made, and an unusual opportunity to appreciate the great importance of confining the operation of freight-train brakes to the use of a single element, were a sufficient incentive to further investigation and experiment. Upon the conclusion of the 1887 trials investigations were again commenced by them, by the direction and under the supervision of Geo. Westinghouse Jr., to determine the extreme possibilities of an approach to simultaneous action of all the brakes of a fifty-car train.

194 The cars upon which the trials in 1887 had been made were the property of the company, and arrangements were made with the C. B. & Q. Railroad Company for the use of locomotives and tracks to enable the experiments to be carried out under the same conditions and upon the identical ground that had been used in the 1886 and 1887 trials. The expense and labor connected with an investigation of this kind were very great, but our previous experience in shop experiments had clearly demonstrated that nothing less could be depended upon in a matter of so great importance.

As bearing upon the necessity for unusual effort that a prompt and accurate conclusion might be reached, it will be well to explain that, up to the time of the Master Car Builders' investigation, the use of power brakes upon freight trains had been confined to Western railroads. These companies operated roads having extremely heavy grades; the use of brakes in general service was almost constant; and a service was therefore had from them of considerably greater value than would be the case with roads more favorably located. Another important feature was the fact that, up to the time mentioned, there was but very little of what is known as "car interchange" upon these roads—that is to say, the cars belonging to the several companies rarely left their own lines, and

the necessity for identity of construction of car apparatus or a thing pertaining thereto was limited.

The different conditions under which Eastern roads were opera probably accounts for their failure to accept the comparative s cess of the Western roads in the use of power brakes upon frei trains as sufficient reason for following their course. The con tions of trade, however, were constantly demanding increased sp and heavier trains, and the power of controlling these trains un the changed conditions was felt to be inadequate, and rapidly gr ing proportionately worse. That there was a great loss of life tendant upon the operation of hand brakes, due to the necess of employees riding and moving upon the tops of trains in moti
was also revealed by carefully compiled statistics; so t
195 combined humanitarian and economic interests requi
that some action should be taken, leading to the general troduction of power brakes upon freight trains. It was in respon to this sentiment that the Master Car Builders' Association ma the investigations heretofore referred to; and the subject was unusual importance in respect to the necessity of a decision t would be complete and final as to the principal characteristics the apparatus to be used.

To accomplish the desired end, it was recognized as absolute necessary that brake apparatus to be used on freight cars shou be at least operatively uniform and interchangeable. Otherwi the great exchange or interchange of car equipment which is n common throughout the entire country would render an expen ture for brakes that would not intermingle and work together e tirely wasteful and without beneficial result.

The conclusion of the 1887 trials, instead of furnishing to t railroads the desired information upon which to take prompt a reasonable action, seemed to show that much yet remained to done before it could be safe to make a practical move in a matter so great importance. These sentiments are clearly expressed in t committee's conclusion from the 1887 trials.

As up to this time the Westinghouse Air Brake Company ha furnished nearly all the apparatus in use in the country, they we naturally in a position to receive reliable information as to t great desire of the leading railroads of the country for an immed ate solution, if possible, of the problem as presented by the resu of the 1887 trials. The general circumstances heretofore describe were sufficient reasons for unusual effort and expense in carryin out our experimental work.

A careful analysis of the quick-action triple valve seemed to sho that it possessed all of the qualities to be obtained through such medium of actuation, and attention was therefore turned to th
accessory portions, such as the train-pipe, hose and couplings
196 and cocks—in fact all of the ordinary details of constructio
which in any manner influenced or controlled the flow o air in the apparatus. The ports of the quick-action triple valv were also enlarged, and with succeeding modifications of this nature

BLEED. T

the interval of application between the first and last brakes on a train of fifty cars was reduced to two seconds.

In obtaining this maximum result the period of time from the middle of May, immediately after the completion of the 1887 trials, until the 1st of October was consumed. As may be imagined, the final result was not obtained at once, but by repeated steps which required the complete refitting of the 50-car train not less than three times. All the resources and employees that could be used were kept at work day and night without cessation, and the material for trial, each time involving more than a car-load, was conveyed from Pittsburgh to Burlington by express, so that no time might be lost When finally, in the latter part of September, 1887, the last brake was applied in two seconds from the time of the movement of the valve by the engineer, the source of objectionable criticism that had heretofore existed against the use of compressed air, unaided by electricity, in the operation of power brakes upon long freight trains, disappeared, and the "quick-action automatic" brake, as then constructed and organized, became and has since been the standard power-brake apparatus for both freight and passenger trains.

A collateral advantage of considerable advantage, due entirely to the modifications made subsequent to the 1887 trials, was realized in an increased efficiency; and it was therefore found possible and desirable to considerably decrease the maximum brake-force, and still stop trains within the short distance realized in the 1887 trials. By this change in brake-force the liability to wheel-sliding was very greatly diminished.

The official character of the tests made by the Master Car Builders' Association, and the great interest taken in them by all railroad managers caused the results of the 1887 trials to be widely dis-
197 seminated and discussed. The leading technical journals contained extended accounts of the experiments as they progressed, and commented upon and elaborated the information that was developed. Necessarily the conclusion of the investigating committee, previously quoted, which stated in terms that no satisfactory conclusion had been reached, was the important and controlling element of this widely spread information.

While the results of our experiments at Burlington were entirely successful, they were necessarily of an unofficial character, as there was no provision by which the Master Car Builders' Association were enabled to take part in them. It was therefore determined that in view of the great uncertainty existing in the minds of railroad men upon the subject, on account of the results of the Master Car Builders' tests, something more than a merely unofficial, and, what might possibly be regarded as a biased, account of the operations of our perfected apparatus should be given.

After careful consideration, it was determined that the best plan by which those interested could become fully and accurately informed would be to approximately repeat the Burlington experiments in as many of the large railroad centres as possible. In executing this arrangement, complete detailed tests were made in the

cities of St. Paul, Chicago, St. Louis, Cincinnati, Cleveland, Buffalo, Albany, Boston, New York, Philadelphia, Washington and Pittsburgh.

To do this it was necessary to convey the entire train of fifty cars, requiring two engines and sometimes three, from point to point; and this necessarily involved its operation under all the usual difficulties of regular traffic. In fact, the circumstances of its extreme length, it being nearly half a mile long, made its operation more than ordinarily difficult, as the train was conveyed over many roads upon which the grades usually limited the length of trains to a much smaller number of cars. The cost of this train, which was the property of the Westinghouse Air Brake Company, was
198 more than $40,000, exclusive of the engines and the hotel car, which was required for the accommodation of those who accompanied the train to conduct its operations, and also to enable railroad men to observe the operations of the train in regular service. An expenditure of about $15,000 was necessary to defray the expense of the journey, which occupied about six weeks and covered 5,000 miles.

At each point where demonstrations were made due notice was given to all railroad men and others interested in the subject, and nearly all of the leading managers accepted the invitation. The final exhibition of the train was made at Pittsburgh in November of 1887, and was the concluding act of a persistent and continuous development of the art of train-braking, carried on for a year with the utmost energy and at a total cost of probably not less than $200,000.

Most gratifying evidence, however, of the value of the result obtained at such great cost was manifested by the receipt of large orders for the new quick-action brakes, immediately following the demonstrations of the exhibition train. In December of 1887, 822 sets were furnished. In the year 1888, 27,696 were supplied; in 1889, 26,065; and in 1890, 50,502. These were all applied to freight cars, and principally upon roads east of the Mississippi river, where, as previously stated, no material attempt had been made to use power-brake apparatus upon freight trains prior to the Burlington tests. The principal trunk lines, such as the New York Central and Pennsylvania systems, have adopted the quick-action brake as their standard, and it is being applied by them to all new cars, and to old cars requiring general repairs.

Previous to the Burlington trials the subject of legislation having in view the compulsory use of power brakes upon freight trains, on account of humanitarian considerations, was seriously considered, but the absence of practical devices rendered legislation on this subject impossible. Since the introduction of the quick-action brake several of the State legislatures have enacted laws
199 making the use of power brakes on freight trains compulsory; and the national legislature have had the subject before them for consideration.

The increased efficiency in train-stopping resulting from the improvements from the invention of the quick-action air brake has

ilso been realized in passenger-car brakes, and a passenger train can be stopped in a distance from 25 % to 40 % less with the quick-action brakes than when the prior "automatic" system was used. This important improvement has been taken advantage of by the principal railroads of the country, and most of the equipment has been changed from the old to the new type.

A final reference to the report of the Master Car Builders' Asso-ciation will be found on pages 48 and 49 of the report of their pro-ceedings for the year 1888. The complete report of the committee on freight-train brakes as there given is as follows:

"In our report to the convention last year the main conclusion we arrived at was that the best type of brake for freight service was one operated by air, and in which the valves were actuated by elec-ricity. Since that time your committee has not made any further rial of brakes, but the aspect of the question has been much changed by the remarkable results achieved in non-official trials which have aken place in various parts of the country, and have been witnessed by many of the members of this association. These trials show that here is now a brake in the market which can be relied on as efficient n any condition of freight service.

"The present position of the freight-train brake is briefly as fol-ows:

"First. Brakes can be, practically speaking, simultaneously ap-plied without electricity throughout a train of fifty freight cars.

"Second. Other inventors are working at the problem of making an air brake which will be rapid in action and suitable for service on freight trains. We also understand that inventors are
200 working at buffer and electric-friction brakes, but we have no reason to hope that brakes upon these principles can success-fully compete with air brakes.

"In view of these conditions, your committee does not recommend he adoption of any particular brake, but considers that a freight-rain brake should fulfill the following conditions:

"First. It shall work with air of seventy pounds pressure. A reduction of eight pounds shall set the brakes lightly, and a restora-ion of pressure shall release the brakes.

"Second. It shall work without shock on a train of fifty cars.

"Third. It shall stop a train of fifty empty freight cars when running at twenty miles per hour, within two hundred feet on a evel.

"Fourth. When tried on a train of fifty cars, it shall maintain n even speed of fifteen miles an hour down a grade of fifty-three eet per mile without variation of more than five miles per hour bove or below that speed at any time during the descent.

"Fifth. The brakes shall be capable of being applied, released and graduated on the whole train by the engine, or without any ssistance from the brakemen or conductor.

"Sixth. The hose coupling shall couple with the present West-inghouse coupling.

"We recommend that all freight cars fitted with such a brake

shall be marked 'air brakes,' on each side of the car and near the top. The committee further recommends the use of iron or steel brake-beams, and that the subject of the best form and proportion of brake-gear, and the selection of a standard solid brake-shoe for use with metallic brake-beams, should be entrusted to a committee appointed for the purpose.

"(Signed) G. W. RHODES.
"GEORGE HACKNEY.
"JOHN S. LENTZ.
"D. H. NEALE."

201 The non-official trials referred to in this report are those made by the exhibition train already described; and the full significance of these exhibitions could probably be indicated in no stronger manner than by the fact that, upon the presentation of the report of the committee just cited, they were discharged with the thanks of the association, after three years of arduous and painstaking investigation, and no further consideration of the subject has been made or found necessary by the association.

A concise statement of the differences in results obtained from the "automatic" apparatus made and used prior to 1886, as compared with the "quick-action" form as made subsequent to the latter part of 1887, and thenceforward, in regular practice, is as follows:

A train of 50 cars, when running at a speed of 20 miles per hour upon a level, required a distance of 350 feet to arrest its motion, with a breaking force so great as to be dangerously near the point of wheel-sliding. The time of full application of the last brake upon the train was 12 seconds. The effect of an "emergency" application of the brakes under existing conditions caused a shock or collision upon the rear car, amounting to 49 inches, as measured by the slideometer; and this action was so objectionable that the use of power brakes under the stated conditions was decided to be impracticable.

A similar train fitted with the "quick-action" automatic brake apparatus, under the same conditions, is stopped in 200 feet, with a braking force limited to a point that renders it almost impossible to cause wheel-sliding. It also has the dual function of the use of auxiliary reservoir pressure alone for service stopping, and the combined power of auxiliary reservoir pressure and train-pipe pressure for "emergency" applications. The last brake in the train is applied within two seconds from the time of the movement of the engineer's valve; and there is no shock or collision sufficient to move the slideometer in the rear car.

202 The effect of these changes leads the Master Car Builders' committee to say that "there is now a brake in the market which can be relied on as efficient in any condition of freight service."

A statement of the effect of the results obtained upon the standard practice in the use of power brakes on freight trains may be made as follows:

Prior to the introduction of the "quick-action" form of brake, air brakes were not used upon freight trains, except upon a few Western railroads with unusually heavy grades, operating trains of moderate length, and when there was but little interchange of freight cars with other railroads. In a period of seven years about 50,000 sets of brakes of the "automatic" brake system were supplied. There was no legislation suggesting or compelling the use of the power-brake apparatus upon freight trains.

Since the introduction of the "quick-action" form of brake, 125,000 sets have been furnished in a period of a little over three years, and these brakes have been principally furnished to the larger Eastern railroad systems, where their use has been made standard. And in several of the State legislatures the use of power-brake apparatus upon freight trains has been made obligatory.

H. HERMAN WESTINGHOUSE.

Henry B. Stone, being first duly cautioned, examined, and solemnly sworn, in answer to interrogatories to him propounded by Mr. Bell, deposes and says:

48 Q. What is your name, age, residence, and occupation?

A. Henry B. Stone; 39 years old; residence, Chicago; occupation, president of the Chicago Telephone Company and of the Central Union Telephone Company.

49 Q. What, if any, education and experience have you had in mechanical pursuits and in railroad service?

A. As a young man I learned the machinist's trade, and worked for several years in various machine shops and drafting-rooms, so that I am generally familiar with machinery. From 1878 to 1890 I was connected with the Chicago, Burlington and Quincy
203 railroad in various capacities, beginning in the motive-power department, where, as master mechanic of a division of the road, and afterwards as superintendent of motive power of the whole road, I had charge of the machinery, including both engines and cars, with all their attachments. I was afterwards general superintendent and then general manager, and, at the time of my leaving in the spring of 1890, was the second vice-president.

50 Q. To what extent have you become familiar with the construction and operation of fluid-pressure brake mechanisms for railroads?

A. While superintendent of motive power and while general superintendent, I gave a great deal of personal attention to the matter of fluid-pressure brakes, and was personally familiar with the construction and operation of the various kinds used by the different railroads of this country.

51 Q. Will you please state briefly the characteristic and distinguishing feature of what are known in railroad practice as "quick-action automatic brakes?"

A. The ordinary air brake, fulfills very well, all the requirements of ordinary service in the handling of trains, that is to say, in making stops under usual conditions at stations, for switches, for water

tanks, and so on; but in cases of emergency, that is to say, when it is necessary to stop a train as quickly as possible to avoid disaster, the ordinary brake is not satisfactory, both because of its comparative slowness of action, but especially because of its causing severe shocks and breakages in long trains when suddenly applied. This latter difficulty arises from its not being simultaneous in its action, or nearly so, on all the cars in the train. In other words, the brakes would apply on the forward cars of the train an appreciable time before they applied on the rear cars, thus checking the forward end of the train to such an extent that the rear cars would run into them, causing serious results from the collision. To make this clear, I would explain that the combined slack of the springs and of the links, between ordinary freight cars, varies from six to twelve
204 inches, so that in a train of fifty cars there is a slack of some twenty-five to fifty feet, dependent upon the character and condition of the couplings. The so-called "quick-action brakes" apply themselves practically simultaneously with full force on all the cars of the train, the result being that as each car has its own brake power applied at the same time as every other car, there is no tendency to collision. The "quick-action brakes" have the further very important advantage of effecting the stop in very considerably less time in the case of a long train than the ordinary brake, from the fact that the brakes are applied on every car practically instantaneously, whereas, with the ordinary brake in the case of a long train, the train often is nearly stopped before the brakes apply at all on the rear car. While the "quick-action brakes" have these advantages, which, in my opinion, are very great over the ordinary brakes, they perform all the functions of the ordinary brake for service stops in a manner equally satisfactory, and, in fact, entirely similar.

52 Q. When, and by whom, so far as your knowledge and information extend, were "quick-action automatic brakes" first introduced into practical service on railroads?

A. By the Westinghouse Air Brake Company, experimentally in 1887, and for practical use on trains in every-day service early in 1888.

53 Q. You were, at the period of their introduction, I understand from your previous testimony, an officer of the Chicago, Burlington and Quincy railroad?

A. I was; I was its general manager at that time.

54 Q. From your knowledge of the conditions and requirements of railroad service, please state to what extent you consider "quick-action automatic brakes" to be of importance and value therein.

A. I consider "quick-action automatic brakes" of the greatest importance in the operation of railways. In fact such brakes are a necessity for the successful, economical and safe handling of freight trains of the present day. I make this statement with ref-
205 erence to the so-called "quick-action automatic brakes" alone, the fact being that the ordinary automatic brakes, of the types in use prior to 1887, are not at all adequate, or even reasona-

bly satisfactory, in the operation of freight trains of the length common on the main trunk lines of the country.

55 Q. To what extent has the practical operation of "quick-action automatic brakes" since their introduction, been found to be useful and valuable, and to comply with the requirements for their production?

A. The "quick-action brakes" have completely fulfilled the requirements, and are being as rapidly applied by the principal railways of the country as their finances will admit. At the time I left the C., B. & Q. road in the spring of 1890, the only question as to how many sets of these brakes should be applied in that year was how many we could pay for.

56 Q. Under what circumstances and in what manner were "quick-action automatic brakes" first experimentally tested in railroad service?

A. At Burlington, Iowa, on the tracks of the Chicago, Burlington and Quincy railroad, on a train of fifty freight cars belonging to the Westinghouse Air Brake Company; in making this statement I desire to be understood as meaning by "quick-action brakes," brakes actuated by air alone, there having been "quick-action brakes" actuated by a combination of electricity and air, shown at Burlington by other inventors earlier in the same year. These experiments at Burlington, to which I refer, were begun at the instance of the Master Car Builders' Association, and under the direction of a regularly appointed committee of its members. The first series of experiments took place at Burlington in the summer of 1886; the second series in the summer of 1887. It was in the fall of 1887, after the second series of experiments had demonstrated beyond question the necessity of a "quick-action brake," that the third series of experiments were made with the Westinghouse "quick-action automatic brake." This latter set of experiments was made under the same conditions in every respect, and on the same
206 tracks as the two preceding series, but were not under the official supervision of the Master Car Builders' committee, that committee having disbanded after the conclusion of the second series. The chairman of the committee, Mr. G. W. Rhodes, and, I think, one or two other members of the committee, were, however, present at the third series and gave the experiments the same personal, close supervision, as individuals, which they had given the other series of experiments as members of the Master Car Builders' committee.

57 Q. Subsequently to the several series of experiments at Burlington specified in your last answer, by whom and in what manner was the practical operation of "quick-action automatic brakes" in railroad service first publicly and successfully demonstrated?

A. By the Westinghouse Air Brake Company, who took the train of fifty cars, each equipped with a "quick-action automatic brake" and gave exhibitions—practical exhibitions of its operation, at Chicago and a large number of other railroad centres of the United States, their exhibition in each case consisting in making stops under the various conditions which occur in every-day practice.

including emergency stops, and stops where the brakes were automatically applied by the train "breaking in two," that is to say where the train separated, through a disconnection of the couplings, into two or more parts. I was personally present at the exhibition at Chicago, which was given on the tracks of the Chicago and Northwestern railway, a short distance out of the city; it was attended by a large number of railroad officers and also by very many locomotive engineers, who were present at the annual meeting of the Brotherhood of Locomotive Engineers, which happened to be sitting in Chicago at that time. The exhibition was an exhaustive one in the way of bringing out the features of the brakes, and all the tests made were entirely successful. I heard but one opinion expressed among the witnesses, which was that, in the familiar language of railroad men, the brake "filled the bill."

58 Q. Was the "quick-action brake," which was used by the Westinghouse Air Brake Company in the demonstrations
207 stated in your last preceding answer, the same as, or different from that which has since been and is now being made and applied by said company?

A. It was the same.

59 Q. In the report of the committee on freight-train brakes, on pages 48 and 49 of the Report of the Proceedings of the Master Car Builders' Association for 1888, I find the following language:

"Since that time your committee has not made any further trial of brakes, but the aspect of the question has been much changed by the remarkable results achieved in non-official trials which have taken place in various parts of the country, and have been witnessed by many of the members of this association. These trials show that there is now a brake in the market which can be relied on as efficient in any condition of freight service."

Can you sate what brake is referred to in the foregoing quotation?

A. I was not a member of the committee referred to, but I have no doubt at all that the Westinghouse "quick-action automatic brake" is the one they referred to. In fact, there were no "non-official trials which had taken place in various parts of the country," except those of the Westinghouse Air Brake Company's train, to which I previously referred.

60 Q. Are you interested in any degree in the result of this suit?

A. I am not.

HENRY B. STONE.

New York, July 18, 1891.

GEO. H. CHRYSTY,
J. SNOWDEN BELL,
For Complainants.
LYSANDER HILL,
Of Counsel for Defendants.

208 United States Circuit Court, District of Maryland.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY *vs.* BOYDEN POWER BRAKE COMPANY; CHARLES A. Boyden, President; Charles B. Mann, Secretary, and William Whitridge, Treasurer.	In Equity. No. 321.

Deposition of H. Herman Westinghouse in cross-examination, and other evidence on behalf of complainants in above-entitled cause, under the 67th rule in equity as amended, pursuant to stipulation heretofore made in this cause and to agreement of counsel, formal notice being waived, before Wm. H. Masson, notary public, as agreed special examiner, at the office of O. Milton Dennis, 23 Chamber of Commerce building, Baltimore, Maryland, commencing on Tuesday, August 18th, 1891, at 10.30 a. m.

Present: J. Snowden Bell, Esq., of counsel for complainants, and Charles B. Mann, Esq., on behalf of defendants.

It is stipulated and agreed that the testimony may be taken by W. H. Masson, notary public, as special examiner, with the same force and effect as before a standing examiner of the court or a special examiner duly appointed and that an order to such effect may be entered *nunc pro tunc* at or before the hearing.

209 H. HERMAN WESTINGHOUSE, being produced for cross-examination in accordance with stipulation, deposes and says, in answer to cross-interrogatories propounded to him by Charles B. Mann, Esq., on behalf of defendants as follows, to wit:

115 X Q. I understand you to state that you have been connected with the Westinghouse Air Brake Company since the year 1872, and that your experience during the past 19 years has made you entirely familiar with the construction and mode of operation of automatic air-brake mechanism for railroads; is this correct?

A. It is.

116 X Q. I also understand you to state that you are familiar with all the experiments and trials that led to the invention and adoption of the quick-action triple valve for air brakes now so largely in use; is this correct?

A. It is.

117 X Q. The triple valve made and sold by the Westinghouse Air Brake Company, and shown in plate D 20 of the Westinghouse 1890 catalogue, is the form in which the invention shown in Mr. Westinghouse's patent No. 220,556, dated October 14, 1879, was put in use by said company, is it not?

Objected to as incompetent, the witness not having been shown to be familiar with the patent referred to, or to be capable of rendering opinions as to the similarity or difference between structures and letters patent.

The question is further objected to as not proper cross-examination, the witness not having testified in chief as to the letters patent inquired about, and his deposition-in-chief relating wholly to matters of fact and not to opinions as to any questions whatever.

A. I have made no attempt to identify the construction of our brake mechanism with our patents, such matters having always been referred to our counsel.

210 113 X Q. Do you wish to be understood as meaning that you are unable to say from your knowledge of these matters whether or not the triple valve shown in plate D 20 of the 1890 catalogue is the form of valve patented to Mr. George Westinghouse, Jr., October 14, 1879?

Same objection, which is continued without further notice as to this entire line of examination as to matters not touched upon in the witness' deposition-in-chief, and to save unnecessary delay, the witness is instructed that he is not obligated to answer any questions as to matters not touched upon, directly or indirectly, in his deposition-in-chief, or as to any matters regarding which he does not feel himself competent or willing to express an opinion.

A. In my direct examination I have not referred at all to the subject of patents, and as an answer to the question involves expressions of opinions upon points upon which I have heretofore made no statements, I do not care to further answer the question.

119 X Q. Did the Westinghouse Air Brake Co. put into use the form of triple valve shown in plate D 20 of the Westinghouse 1890 catalogue during the eight years between 1879 and 1887?

A. It did.

120 X Q. State whether or not, during that period, all of the Westinghouse triple valves for car service were made in that form, and, if not, what proportion of them were made in that form.

A. They were not all made in the form shown on plate D 20, and without being able to state accurately, I should say that probably about one-third of our product was of the kind mentioned between those years.

121 X Q. Will you please indicate, by reference to the plate in the Westinghouse 1890 catalogue, what form of triple valve was employed for the other two-thirds of the valves made during that period?

211 A. The other form of triple valve is not illustrated in the 1890 catalogue, to which I have heretofore referred. I have no copy of the 1886 catalogue here, in which it is illustrated.

122 X Q. I understand you to have stated that you are entirely familiar with the construction and mode of operation of the various triple valves made and sold by the Westinghouse Air Brake Co.; now, I desire to ask you, with reference to the triple valve shown in plate D 20 in the 1890 catalogue, whether it is not a fact that when making a "graduating" application of the brakes with that form of triple valve, it was intended to let the air flow from the aux-

iliary reservoir to the brake-cylinder only by the small passage through the main valve controlled by the small valve?

A. When making a "graduating" application of the brake, it was intended that the air should pass from the auxiliary reservoir to the cylinder through the opening controlled by the small valve.

123 X Q. You have stated that automatic brakes, when using triple valves of this form, perform all the usual operations of braking known as "service stops" in an entirely satisfactory manner; you then go on to refer to the unsatisfactory manner in which this form of valve made "emergency stops." I now desire to ask you how the "emergency stops" with that old form of valve were made?

A. By exhausting air as rapidly as possible from the train-pipe on the locomotive.

124 X Q. State what action this exhaustion of air produced on the triple valve whereby it made the "emergency stops"?

A. It reduced the pressure on the train-pipe side of the triple-valve piston as rapidly as possible, with the mode of operation as described in the answer to the previous question.

This results in the quickest movement of the valve controlling communication between the auxiliary reservoir and the brake-cylinder, and also makes the largest port opening for the
212 flow of air pressure to the brake-cylinder that is possible in connection with limiting conditions.

125 X Q. This making of the largest port opening allows the air to flow from the auxiliary reservoir to the brake-cylinder more freely and quickly than is possible when the small "graduating" valve alone is open, does it not?

A. The largest possible port opening may be considerably less than the one controlled by the small "graduating" valve.

126 X Q. Well, as a matter of fact as used in practice, is not the port of the "graduating" valve smaller than the largest port opening you have referred to?

A. In the majority of the triple valves we have made between the years 1879 and 1887, there is but one port leading from the auxiliary reservoir to the brake-cylinder and this is controlled by the "graduating" valve.

127 X Q. Is the triple valve shown in the plate D 20 in the 1890 catalogue, one of the kind which has but one port leading from the auxiliary reservoir to the brake-cylinder, and which port is controlled by the "graduating" valve?

A. It is not. The valve has a single opening leading from the auxiliary reservoir to the brake-cylinder controlled by the graduating valve and also by a portion of the slide-valve.

128 X Q. Is not the port of the "graduating" valve shown in plate D 20 smaller than the port formed in the casing of the valve which is controlled by a portion of the slide-valve?

A. It is.

129 X Q. And in order to serve the purpose of an "emergency stop" with any degree of satisfaction, is it not necessary that the

port which is referred to in the last question as being in the casing, should be larger than the "graduating" port?

A. It is not necessary that it should be larger.

130 X Q. Why?

213 A. Because there is no reason why the port controlled by the "graduating" valve should not be as large as the one leading through the valve casing from the auxiliary reservoir to the brake-cylinder.

131 X Q. Will not a larger port allow the air to pass from the auxiliary reservoir to the brake-cylinder more freely and quickly than a small one?

A. It will, provided the port is unobstructed.

132 X Q. I take it that when, in your examination-in-chief, you referred to "service stops" and "emergency stops" as made by the triple valve in use prior to the year 1887, the port through which air passed to the brake-cylinder when making "emergency stops" was larger than the port of the "graduating" valve; am I right or not?

A. My testimony was of a general nature, and did not refer to specific constructions, but as previously stated, the majority of our triple valves had but a single port controlled by the "graduating" valve.

I therefore did not have in mind the opening of a larger port for emergency purposes.

133 X Q. I now understand from an explanation which you have made, not on the record, that the majority of triple valves used prior to the year 1887 were on freight cars, and such valve had but a single port controlled by the "graduating" valve. I also understand that triple valves made like that shown in plate D 20 of the catalogue of 1890 were used on passenger cars, and that such valves had a port through which air passed to the brake-cylinder, when making "emergency stops," that was larger than the port of the "graduating" valve; is this correct?

A. Your understanding of the matter is substantially correct.

Mr. Mann states: I may hereafter ask you to designate on the Westinghouse catalogue of 1886, the plate which shows the style of triple valve used on freight cars to which you have referred.

214 134 X Q. You have stated that the improved operation known as "quick action," is obtained by an *addition* to the mechanism of the triple valve, as shown in plates D 1, D 22, D 26, D 31 of the Westinghouse catalogue of 1890; such "addition" comprises the direct passage from the drain-cup of the valve case to the brake-cylinder, and the auxiliary valve controlling that passage, does it not?

A. There is a direct passage from the drain-cup or train-pipe to the brake-cylinder, controlled by an auxiliary valve, and these are comprised and are an addition in the improved "quick-action" triple valve relatively to the old triple valve.

135 X Q. I now have a copy of the Westinghouse catalogue of 1886; will you please designate in the catalogue the plate of the

BLEED. THRO

triple valve which you have stated was used on freight cars prior to the year 1887?

A. Plate B 25 is the one which illustrates this triple valve.

136 X Q. When was the "quick-action" triple valve shown in plates D 1, D 22, D 26, and D 31, adopted by the Westinghouse Air Brake Co.?

A. This valve was adopted by them about December, 1887.

137 X Q. Is this the valve that was patented January 24th, 1888, No. 376,837?

Objected to as incompetent, the witness not having been shown to be familiar with the patent referred to, or to be capable of rendering opinions as to the similarity or difference between structures and letters patent.

The question is one of law for the court, and not proper or competent for the witness to pass upon.

The question is further objected to as not proper cross-examination, the witness not having testified in chief as to the letters patent inquired about, and his testimony-in-chief relating wholly to matters of fact.

Answer is made that the question relates strictly to a
215 matter of fact which is doubtless within the knowledge of
the witness. The question does not call for the expression of opinion as to the similarity or difference between structures or letters patent.

Counsel for complainant- replies that the question of what is patented in and by the letters patent referred to, or any other letters patent, is a question of law pure and simple, and is not, therefore, a proper question for the witness to answer, being one for the determination of the court. The structure referred to in the question is before the court, of record, and counsel for defendants can, if he desires, offer in evidence the patent about which he inquires, and, at the hearing, obtain the court's opinion as to the identity or difference of said structure and of said patent, offering, if he deems proper, such testimony on behalf of defendants as may serve to support whatever view in the case he adopts and believes to be the correct one. He cannot, however, use this witness in support of his views upon this, or any other question of law, and without consuming further time in argument upon the record, the witness is instructed that he is not obligated to answer this or any other question calling for his opinion upon a matter of law.

138 X Q. State whether or not the quick-action triple valve which you say was adopted by the Westinghouse Co. about December, 1887, and which is shown in plates D 1, D 22, D 26, D 31 of the 1890 catalogue has been patented?

Same objection, which is continued without further notice as to the entire line of examination relating to letters patent, the identification of structures therewith, or the comparison of letters patent one with another, or with a structure or structures.

216 A. I have made no attempt to identify patents taken o
or owned by our company with the construction of o
apparatus.

The answer is objected to because it is not responsive and t
witness' attention is called to the fact.

(Witness continues:) The answer is as responsive as the know
edge I have justifies me in making.

139 X Q. You are general manager of the Westinghouse A
Brake Co. and I believe you have had much to do with such ma
ters as relate to newly patented improvements on various parts
the air-brake system, and with such matters as the purchase
patents relating to such new improv-ments. In view of this I no
ask you if you have not often seen and examined copies of paten
belonging to the Westinghouse Air Brake Co. relating to quick
action triple valves?

Same objection, and further objected to as immaterial.

A. As general manager of the company I have had less to d
with the patent matters connected with our operations than an
other department of our business. I have seen and examined pat
ents relating to quick-action brakes.

140 X Q. Are you not aware that the quick-action triple valve
made by your company bear the mark of two patents, to wit, March
29th, 1887, and January 24th, 1888?

A. I am not aware that that is the fact.

141 X Q. Please state what are the facts with regard to the paten
marks on the quick-action triple valves made and sold by your
company?

A. I do not know the facts connected with marks on the quick-
action triple valves made and sold by our company.

142 X Q. I understand that you do not deny that the date of
January 24th, 1888, is the correct date of the patent on the
217 quick-action triple valve now in use by your company, and
which was adopted by them about December, 1887, but only
that you cannot state whether that date is on the triple valves that
are made and sold, am I right?

Same objection, the question being merely a paraphrase of that,
to wit, cross-question No. 137, with which counsel began his inquiry
upon the question of the identity of structures with patents.

A. I do not deny it, for the reasons previously stated. I am absolutely ignorant of what marks, patent or otherwise, are upon our
triple valves.

143 X Q. What quick-action triple valve did you refer to in your
examination-in-chief as being one which the Westinghouse Air
Brake Company, since December, 1887, has furnished to railroads
for car service, substantially to the exclusion of all others?

A. The one illustrated on plate D 22 of our 1890 catalogue.

144 X Q. You stated that about 125,000 quick-action triple valves

are now in general use; please state what valves are here referred to?

A. The valve referred to on plate D 22 of our 1890 catalogue.

145 X Q. Did you make the affidavit to the bill of complaint in this suit?

A. I did.

146 X Q. That bill of complaint sets up a charge of infringement as to letters patent of March 29th, 1887, No. 360,070, does it not?

Objected to, first, as not being proper cross-examination, having no reference whatever to the witness' deposition-in-chief, and, second, as calling for secondary evidence, the bill of complaint being the best evidence, and the same being before the court, and the witness not being competent to explain or construe such written instrument.

218 Answer is made that the witness is not asked, and will not be asked, to explain or construe any of the allegations set forth in the bill of complaint. He is asked a simple question, which certainly is within his knowledge.

Counsel for complainants repeats that the bill of complaint, of record, is the best evidence, and that the witness is not competent to state what it "sets up," that matter being, like the remainder of the pleadings, one for the consideration and determination of the court.

A. I don't remember whether it does or not.

147 X Q. Do I understand you to mean that although you are so largely interested in the matters involved in this suit, yet you do not know anything about what patent is sued on in this suit; is this so?

Same objection, and the witness is requested to refrain from expressing any opinion as to his understanding of the pleadings in this cause or any other matter of law connected therewith or relating thereto. What the bill sets up, and every other matter pleaded, is of record, and will be determined by the court much better than it can be by the witness, and in accordance with the rules of law governing such questions.

Answer is made that the question involved an inquiry simply as to what the witness knew, and did not call for any expression of opinion as to the pleadings in this cause.

A. I simply mean to state that I have not specifically charged my mind with details connected with this suit which have been referred to by counsel, and I am therefore unable to speak accurately and definitely upon the point in question.

148 X Q. You have testified in regard to the tests of air brakes that were made at Burlington, Iowa, in the years 1886 and 1887, and you have stated that you are familiar with all the experi-
219 ments which led up to the adoption of the quick-action triple valve now in general use. I now ask you if, after the Burlington tests of 1886, which developed the inability of the old triple valve to prevent severe shock in long trains, Mr. George Westing-

house, Jr., set to work to overcome that defect, and what was the first quick-action triple valve that he produced in his effort in that direction?

A. After the Burlington tests of 1886, Mr. George Westinghouse, Jr., did commence experiments to overcome defects developed in the preceding brake trials. The first form of quick-action triple valve is illustrated in the blue-print drawing No. 2681, which I here present.

The blue print referred to by the witness is here offered and put in evidence, and is marked "Complainants' Exhibit Blue Print, First Form of Quick-action Triple Valve."

149 X Q. I observe, by a comparison of the valve shown on this blue print with the valve shown in letters patent 360,070, March 29th, 1887, to George Westinghouse, Jr., that the said blue-print valve is the same as that shown in the patent referred to, which is the patent in suit. I now ask you if this is in accord with your understanding of the matter?

Same objection as heretofore entered relatively to the incompetency of questions calling for a comparison of structures with letters patent. Both the patent and the blue print are in evidence, and defendants' counsel can, if he deems it necessary or desirable so to do, adduce the testimony of a witness expert in such comparisons on behalf of defendants.

The question is also objected to because the assumption contained in the first sentence thereof makes defendants' counsel a witness.

Answer is made that whether the assumption in the first part of the question makes me a witness or not can be a matter of
220 no consequence, since the simple question to the witness is, as to whether what is stated is in accord with his understanding of the matter. If it is not in accord with his understanding the witness can say so, and if it is in accord with his understanding why certainly he can say so, and now I leave the matter with the witness.

A. I have made no comparison of the patent drawings mentioned and the blue print in evidence, and, as heretofore stated, I do not care to take up the question of relation of patents to structures.

150 X Q. I have not asked you nor will I ask you to take up the question of the relation of patents to structures. I supposed that I was asking you a simple question that you fully understood. I will now ask you if you have not testified that you were at one time in the draughting department of the Westinghouse Air Brake Co., and whether you consider yourself, notwithstanding your experience in such matters, incompetent to pass on so simple a matter as the comparison of two drawings with which you are already familiar?

A. I was formerly in the draughting-room of the Westinghouse Air Brake Company, and, so far as I can remember, there is nothing in my testimony indicating my inability or unwillingness to

made a comparison between drawings. In a former answer I simply stated that I had not made the comparison you asked for.

151 X Q. Then, as I now understand that you do consider yourself competent to compare the valve shown in the blue-print drawing with the valve shown in the drawings of letters patent No. 360,070, which is in suit, and to state whether or not they are substantially the same, I will therefore ask you to make such comparison, and state whether or not they are the same?

A. So far as I can discover, the drawing represents substantially the same construction.

221 152 X Q. Then, I understand that the first form of quick-action triple valve which was gotten up by Mr. George Westinghouse, Jr., after the Burlington test of 1886, is shown in the drawings of patent 360,070?

A. It is.

153 X Q. Will you now please state whether or not quick-action triple valves made like that shown in the drawings of patent 360,070 were tried on a fifty-car train at the second test in 1887 at Burlington?

A. Valves of the general form of the kind indicated were used at the time stated, but I am not sure as to the exact identity of the construction of the valves there used and the drawings heretofore mentioned. They were however substantially of the construction shown in the patent drawing.

154 X Q. Were the valves tried at the second Burlington test which you say were substantially like the drawings of patent 360,070, painted red?

A. Possibly they were, but I cannot speak definitely on this point.

155 X Q. I understand you to state that the result of the May, 1887, Burlington test of these valves was that there was greater and more severe shock on the rear cars than there was with the old-style triple valve that was tried in the test of 1886, is this correct?

A. It is true that the general organization of the brake-equipment of the 1887 trials produced greater shocks than were experienced in the 1886 trials.

156 X Q. Upon the conclusion of the second brake-trials in May, 1887, where the Westinghouse train was equipped with triple valves made like the drawings of patent in suit, No. 360,070, I understand the committee of master car-builders decided that although the Westinghouse train made stops in a less time and a shorter distance than in the year 1886, yet this record "was completely spoiled by the fearful shocks given at the rear end," is this correct?

A. That was the opinion expressed by the committee, with which I do not coincide.

Adjourned to meet tomorrow Wednesday, August 19th, at 10.30 a. m.

222

AUGUST 19TH, 1891.

Met pursuant to adjournment.
Present: As before.

Cross-examination of H. HERMAN WESTINGHOUSE continued:

157 X Q. Did you not state in your examination-in-chief, in regard to the second brake-trials at Burlington, May, 1887, with the train of the Westinghouse Co. having valves substantially like the drawings of the patent in suit No. 360,070, that in making "emergency stops" "the shocks experienced in the preceding year were greatly exceeded, reaching a maximum of 103 inches (by the slideometer), as compared with the maximum of 49 inches in the 1886 trial. *In fact, they were so severe that it was not deemed prudent to use the brake in 'emergency' applications without the use of the electrical valves?*"

A. I believe that my testimony is substantially in accordance with the statement you have made.

158 X Q. At the second Burlington test, made May, 1887, a train of fifty cars was tried, equipped with valves substantially like that of the drawings of the patent in suit No. 360,070, and in regard to this you stated, "the conclusion of the 1887 trials, instead of furnishing to the railroads the desired information upon which to take prompt and reasonable action, seemed to show that much yet remained to be done before it could be safe to make a practical movement in a matter of so great importance." Is this correct?

A. The quotation is substantially correct.

159 X Q. I understand from your testimony, that upon the conclusion of the 1887 trials at Burlington, persons connected with the Westinghouse Co. "*again commenced*" investigation by the direction and under the supervision of George Westinghouse, Jr., with the object in view of providing means to produce more satisfactory results in quick action of brakes on a fifty-car train. Is this correct?

223 A. It is.

160 X Q. I understand you to state, in substance, that the period of time between the conclusion of the 1887 trial (May) and the latter part of September, 1887, was consumed by a force of employees of your company, under the supervision of George Westinghouse, Jr., in experiments to get improved results, and at the end of that time they succeeded in obtaining a newly constructed and differently organized quick-action triple valve that was satisfactory. Is this correct?

A. I do not remember having testified to the facts as stated.

161 X Q. Please to take up the question 160 last asked, commencing with the first statement made therein, and point out to me what statements are correct and what are incorrect?

A. The first statement in the question relating to experiments having been made between the period May, 1887, and latter part of September, 1887, under the direction of Mr. George Westinghouse, Jr., for the purpose of obtaining improved results, is substantially in accordance with my testimony and is correct.

The second statement in the question, that at "the end of that time they succeeded in obtaining a newly constructed and differently organized quick-action valve that was satisfactory," I do not remember to have heretofore made, but the statement is substantially correct.

162 X Q. Please designate on the Westinghouse catalogue of 1890, if it is there illustrated, the triple valve which was satisfactory and which was obtained about the latter part of September, 1887?

A. The catalogue of 1890 contains but one of the triple valves that were found to be satisfactory at the conclusion of the experiments in September, 1887, and one of the satisfactory ones is illustrated on plate D 22 of the 1890 catalogue, also in plates D 26 and D 31.

163 X Q. Please look at the drawings of patent No. 376,837, dated January 24th, 1888, and state whether the quick-action triple valve there shown is the one that was developed at Burlington between May, 1887, and the latter part of September, 1887?

221 A. Yes, it is.

164 X Q. And this valve shown in the drawing of patent 376,837 was thereupon, about December, 1887, adopted by the Westinghouse Co. as its standard form of quick-action triple valve, and has been continued in use as such ever since; is not this the fact?

A. The construction of the valve indicated was adopted as the standard about December, 1887, and has continued substantially the standard ever since.

165 X Q. Does the Westinghouse catalogue 1890, the one now in use, contain any plates or illustrations of "quick-action triple valves" like that shown in the drawings of the letters patent No. 360,070?

A. It does not.

166 X Q. Please state whether or not the type or form of "quick-action triple valve" which is shown in the drawings of the patent No. 360,070 was ever illustrated in any catalogue issued by the Westinghouse Air Brake Company?

A. I believe it was not.

167 X Q. Is the Westinghouse Air Brake Company now making and selling "quick-action triple valves" of the type or form shown in the drawings of the letters patent No. 360,070?

A. They are not.

168 X Q. Are any "quick-action triple valves" like that shown in the drawings of the patent No. 360,070 now in regular use on railroads; if yea, state where?

A. Valves of the kind indicated are now in use on the Atchison, Topeka and Santa Fé R. R.

169 X Q. State how many of such valves are in use on that railroad?

A. While I have not accurate information on that point, to the best of my knowledge the number is between 1,500 and 1,800.

170 X Q. I understand you to say that the Atchison, Topeka and Santa Fé railroad now has from 1,500 to 1,800 "quick-action triple valves" made like that shown in the drawings of patent 360,070;

POOR COPY

now please state when these valves were sold and delivered to that company?

225 A. During the year 1887, but prior to the month of December.

171 X Q. What kind of cars are those valves on?

A. Freight cars.

172 X Q. Then I understand from your testimony that although the valves that we are now discussing, made like the drawings of patent No. 360,070, produced severe shocks on long trains at the Burlington test, which shocks were so severe that it was admitted by the committee in charge of the test, and admitted by yourself, where you stated "that it was not deemed prudent to use the brake in emergency applications without the use of the electrical valve," yet, notwithstanding this impracticable aspect of the matter, *yet* the Atchison, Topeka and Santa Fé railroad have continued to use those valves until the present time; is this correct?

This question is objected to as argumentative and improper in form, and further as misleading, in assuming conclusions not stated in or warranted by the witness' deposition-in-chief, or thus far in cross-examination.

Counsel for defendants now requests counsel for complainants to distinctly point out in cross-question No. 172 anything that is misleading in that it assumes conclusions not stated in the deposition of the witness or in his cross-examination.

In compliance with the request of counsel for defendants, counsel for complainants points out that the question is misleading in that it assumes that the witness has stated that "the valves that we are now discussing made like the drawings of patent No. 360,070" produced severe shocks on long trains at the Burlington test while, as a matter of fact, the witness has made no such statement as to the valves. He has admitted that severe shocks were experienced at the Burlington test, but he has not said anywhere that such
226 shocks were due to, or were produced by, the valves that we are now discussing, or by valves made like the drawings of patent No. 360,070. Further, he has not said anything which warrants the use of the term "impracticable" in the question, such term being applied, as counsel understands it, to the valves referred to in the question.

Counsel for defendants rejoins and says that a large part of the testimony of the witness has related to explanations about the valves used in the tests at Burlington in 1887—valves like the drawings in patent No. 360,070, and to shocks that were produced on the cars when those valves were used.

He also distinctly attributed those shocks to the action of the valves.

Further, his own testimony, and quotations he gives in his testimony from the report of the car-builders' committee, show that a triple valve, which produced or gave rise to such "shocks" as were made at Burlington when the valves in question were tried, would be impracticable for railroads on long trains. To show what the

BLEED THROU

witness has stated with reference to these valves. I will make a few quotations from the long statement which he made in his examination-in-chief.

"The discharge port from the auxiliary valve was, therefore, connected with the brake-cylinder instead of leading it to the atmosphere. The effect of this modification was to cause a considerable amount of the pressure in the train-pipe to pass into the brake-cylinder, where it contributed to that regularly supplied by the auxiliary reservoir, augmenting the brake force fully twenty per cent. in emergency or quick applications."

"Provision was made whereby the benefits of the improvements were applicable to the automatic apparatus already in use. This was accomplished by a form of valve mechanism entirely
227 independent of the triple valve of the automatic system, and arranged to control communication between the brake-pipe and the brake-cylinder."

"By the improvements described in triple-valve construction, the interval of applications between the first and last cars of the test train was reduced from twelve to six seconds."

I now give a quotation found in Mr. Westinghouse's testimony, which he quotes from the report of the car-builders' committee: "The Westinghouse Brake Company, unwilling to accept as final their May, 1887, record, is making changes in valves and piping, by which they hope to make short fifty-car emergency stops, without objectional shocks and without the aid of electricity."

I now quote from the testimony of Mr. Westinghouse:

"The results obtained with the new quick-action valve (the one tried in May, 1887) of the Westinghouse Company were, in some respects, extremely satisfactory and in others disappointing."

I now quote from the committee of car-builders as given by Mr. Westinghouse:

"Now comes the still more astonishing story. In these electrical stops the slideometer never moved, and this with the same cars, the same leverages, and the same pressures, the only difference being the time of application."

Counsel for complainants, submitting to the court that the above quotations made by counsel for defendants wholly fail to justify his inferences therefrom, and his assumption in the question that "the valves we are now discussing" produced the severe shocks at the Burlington test, deems it unnecessary to argue the matter further on the record.

A. I have not intended to testify that the form of valve
228 under discussion, that was used in the 1887 trials, was the cause of the objectionable shocks that were produced in the trains upon which those valves were used. I had intended to be understood that with the entire brake-equipment organized in the manner used upon the train in question, that their general operation was unsatisfactory, when used under the conditions that existed when the trials were made. As a matter of fact, these valves, when provided with the proper accessories, such as are now fur-

nished with brakes sold by us, performed in an entirely satisfactory manner. The shocks in a fifty-car train, equipped with these valves and proper accessories, was less than what was experienced in the 1886 trials. By enlarging the passages controlling the flow of air direct from the train-pipe to the cylinder, and without any modification or departure from the principle or form of construction shown in drawings of patent 360,070, results identical with those produced by the valves shown on plate D 22 of 1890 catalogue were obtained.

In view of these facts it is manifestly untrue that the form of valves used in the May, 1887, trials at Burlington was responsible for the objectionable shocks.

173 X Q. I believe you have nowhere testified heretofore that the enlargement of the passages of the valve in question through which the air flowed direct from the train-pipe to the brake-cylinder produced satisfactory results in the tests made at Burlington in May, 1887, have you?

A. I have not, and do not now intend to convey the impression that these enlargements were made during the May, 1887, master car-builders' brake trials.

174 X Q. Does not your testimony contain the statement substantially that at Burlington, in May, 1887, when valves like those in the drawings of patent No. 360,070 were used without the electrical attachment, such shocks were produced; "that it was not deemed prudent to use the brake in emergency applications," but when the electrical attachment was used, with the same valves and the same equipment otherwise, there was no shock and the slideometer did not move; is not this so?

229 A. I have testified substantially to that effect, but wish to explain that the electrical attachments spoken of are not a portion of the triple-valve mechanism, and had no direct connection with the triple valves. They were located in the train-pipe at about the fifteenth and twenty-fifth cars. Their mode of operation was to cause an opening in the train-pipe coincident with the operation of the engineer's valve, and thereby aided reduction of pressure in the train-pipe.

175 X Q. Then I understand from your testimony that the effect of the electrical attachment referred to, was to so accelerate the reduction of pressure in the train-pipe that the triple valves, with this assistance, were able to make a stop without shock; is this correct?

A. Your understanding of the matter is substantially correct, and with the same systems ordinary triple valves would produce stops without shock.

176 X Q. I understand that the valves with which the electrical attachment was used at the time referred to were like the valves shown in the drawing of patent No. 360,070; is this correct?

A. It is.

177 X Q. The defendants have in their possession a valve which you sent to the Boyden Company in exchange for one of theirs, and

I ask you if that valve which you sent to them is like the valves that were used in the May, 1887, Burlington trials?

A. I do not know, but I presume it is, as it was our intention to send a valve of that kind.

178 X Q. Please look at the drawing of the patent No. 393,784, dated December 4th, 1888, to Harvey S. Park, and state whether or not it shows a quick-action triple valve, and whether said patent belongs to the Westinghouse Air Brake Co.?

Objected to as not proper cross-examination, and further as immaterial.

A. The drawing shows a form of valve that, properly con-
230 structed, will be of a quick-action type, and the patent is the property of the Westinghouse Air Brake Co.?

179 X Q. I understand that the Westinghouse Air Brake Co. owns three types or forms of quick-action triple valves, to wit, that like the drawings of patent No. 360,070; that like the drawings of patent No. 376,837, and that like the drawings of patent No. 393,874. Is this correct?

A. It is.

180 X Q. Do you not consider that the quick-action triple valves shown in the drawings of each of the three patents just named is for the purpose of accomplishing the same result?

A. I do.

181 X Q. The drawings of said three patents show three distinct and different ways of accomplishing the quick-action result in automatic air brakes, do they not?

A. I regard the method of accomplishing quick action in air brakes as the same in each case, but different mechanical devices are employed in each instance.

182 X Q. I will state briefly my understanding of the operation of the valve described in each of the three patents. In patent No. 360,070 the valve which controls communication direct between the train-pipe and the cylinder is opened by means of the triple-valve piston acting mechanically upon it; in patent No. 376,837 this valve is opened by auxiliary reservoir pressure acting independently of the mechanical action of the triple-valve piston, and in patent No. 393,784 this valve is opened by train-pipe pressure acting directly on it. Is this statement correct?

A. So far as the operations described are concerned I regard it as substantially correct.

183 X Q. Inasmuch as there are now three types of "quick-action triple valves" to which reference has been made in the last few questions, for automatic air brakes, I would ask you do you think it impossible for a fourth type of this class of valves to be devised?

A. I do not.

231 184 X Q. Did you make the affidavit to the bill of complaint in the two equity suits now pending in the circuit court of the United States for the southern district of New York, where the Westinghouse Air Brake Company sues the New York Air Brake Company for an alleged infringement, among other

things, of two patents relating to quick-action triple valves, one being patent dated January 24th, 1888, No. 376,837, issued to George Westinghouse, Jr., and the other patent dated December 4th, 1888, No. 393,784, issued to Harvey S. Park; and is it not the fact that patent No. 360,070 in this suit is not included in the bills of complaint in the New York suits?

Objected to as not proper cross-examination and as immaterial.

A. I did, and as I am advised that patent 360,070 was not included in either of the New York suits, I will admit such to be the fact.

It is hereby stipulated and agreed that copies of the 1886 and 1890 catalogue of the Westinghouse Air Brake Company may be referred to at the hearing by either party with the same force and effect as if the same had been formally offered in evidence.

Redirect examination by J. SNOWDEN BELL, Esq., of counsel for complainants:

185 Q. Please state in what manner automatic air-brake apparatus manufactured and sold by the Westinghouse Air Brake Company is marked for the purpose of indicating letters patent under or in accordance with which such apparatus is made.

A. By instruction of counsel we have prepared a plate bearing dates of various patents owned or controlled by the Westinghouse Air Brake Company, under which their apparatus is made, and this plate is attached to the air pump of the locomotive where it is plainly visible.

232 186 Q. By whom or under whose direction are the several dates of patents placed upon this plate?

A. By direction of the company's counsel.

187 Q. Is the determination of questions relating to letters patent any part of your duty as general manager of the Westinghouse Air Brake Company, and, if not, to whom are such questions referred, and by whom are they determined?

A. It is not a part of my duty, and such matters are referred to and determined by the company's counsel.

188 Q. You have stated in your answer to cross-question 162 that your company's catalogue of 1890 contains but one of the triple valves that were found to be satisfactory at the conclusion of the experiments in September, 1887. Can you produce an illustration substantially representing any other quick-action triple valve that was found to be satisfactory at that period?

A. The triple valve represented in "Exhibit Blue Print, First Form of Quick-action Triple Valve," when modified in some of its proportions, and when embodied in a brake apparatus, having its accessory parts properly proportioned and constructed, produces results equal to the best that were had from any of our quick-action triple-valve constructions.

189 Q. To what extent, if at all, other than as to dimensions or proportions, does the modification referred to in your last preceding

answer involve a departure from the structure and designed manner of operation of the quick-action triple valve represented in "Exhibit Blue Print, First Form of Quick-action Triple Valve"?

A. The modifications involve no change in structure, design, or mode of operation, and were confined entirely to the size of ports leading directly from the train-pipe to the brake-cylinder.

190 Q. By the term "accessory parts" employed by you in your answer to Q. 188, are we to understand that you mean any devices or parts other than or additional to those ordinarily employed in automatic air-brake apparatus, and employed at the date of
233 the Burlington 1887 trials, and, if so, to what other or additional devices or parts do you refer?

A. In speaking of "accessory parts," I did not refer to any additional devices or mechanism ordinarily employed in automatic air-brake apparatus or in use at the Burlington 1887 trials. I referred to such portions of the equipment as the train-pipe, the hose and couplings, the cocks, the branch pipes, the passages leading from the triple valve to the brake cylinder, and all of the elements ordinarily employed in air-brake apparatus that control or limit the free flow of air from the train-pipe directly to the brake-cylinder.

191 Q. From your knowledge of and experience in the art of automatic air-brake construction, please state whether or not you believe a triple valve as represented in "Exhibit Blue Print, First Form of Quick-action Triple Valve," having its ports leading directly from the train-pipe to the brake-cylinder of proper proportions or dimensions, and embodied in a brake apparatus having the "accessory parts" to which you have referred properly proportioned and constructed, to be "impracticable," or not suitably or desirably adaptable to practical railroad service?

A. I believe the valve mechanism constructed in accordance with the blue print mentioned furnishes a practical and entirely satisfactory quick-action triple valve.

Recross-examination by Charles B. Mann, Esq.:

192 X Q. Admitting that the determination of questions relating to letters patent are not part of your duty as general manager of the Westinghouse Company, I ask is it not a fact that you have felt an especial interest in the several patents belonging to that company, and covering the three types of quick-action triple valves, and that you have frequently examined them and are more or less familiar with them?

A. It is a fact.

193 X Q. Is not the blue-print drawing, referred to in re-
234 direct question and answer 188, a working drawing, and does it not bear date January 5th, 1887, which was previous to the May, 1887, trials?

A. I presume it is a working drawing, and it does bear that date.

194 X Q. Were not the quick-action triple valves, which were tested in the May, 1887, trials, made, proportioned and constructed in accordance with this blue-print drawing?

A. I presume they were, but on this point I cannot speak definitely.

195 X Q. Is it not the fact that the train on which these severe shocks were produced in May, 1887, had valves that were made in accordance with the "blue print, first form of quick-action triple valve"?

A. I believe the valves on the train mentioned were substantially in accordance with the blue print.

196 X Q. Have any valves like that shown in the "blue print first form of quick-action triple valves" been made and sold by your company since December, 1887?

A. I believe not.

H. HERMAN WESTINGHOUSE.

Counsel for complainants offers and puts in evidence a certified copy of license from George Westinghouse, Jr., to the Westinghouse Air Brake Company, dated November 22d, 1880, and recorded in Liber Q 26, page 36, and the same is marked "Complainants' Exhibit License No. 1."

Also a certified copy of license from George Westinghouse, Jr., to the Westinghouse Air Brake Company, dated November 7th, 1890, and recorded in Liber L 43, page 49, and the same is marked "Complainants' Exhibit License No. 2."

Adjourned *sine die.*

235 United States Circuit Court, District of Maryland.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY *vs.* BOYDEN POWER BRAKE COMPANY; CHARLES A. Boyden, President; Charles B. Mann, Secretary, and William Whitridge, Treasurer.	In Equity. No. 321.

Depositions of witnesses and other evidence in reply on behalf of complainants in the above-entitled cause, taken under the 67th rule in equity, pursuant to notice, before F. E. Gaither, notary public, as agreed special examiner, at the office of Messrs. Kerr & Curtis, No. 120 Broadway, New York, commencing on Friday, November 24, 1893, at 10:30 a. m.

Present: J. Snowden Bell, Esq., of counsel for complainants, and Lysander Hill, Esq., of counsel for defendants.

HENRY F. NEWBURY being recalled, deposes and says, in answer to interrogatories propounded to him by J. Snowden Bell, Esq., of counsel for complainants, as follows, to wit:

197 Q. Are you the same Henry F. Newbury who has heretofore testified in this cause?

A. I am.

198 Q. Have you read the depositions of defendants' witnesses George A. Boyden and Joseph B. Church, in this cause?

A. I have.

236 199 Q. Defendants' witnesses Boyden and Church appear to be of the opinion that a material difference exists between complainants' and defendants' devices, when operating as quick-action triple valves, by reason of the fact that, in defendants' quick-action triple valves, compressed air, both from the auxiliary reservoir and from the train-pipe, passes through the port controlled by the valve 22.

Please state at what point, in the Westinghouse quick-action valve of patent 360,070 in suit, these two air pressures unite, and state, with your reasons, whether the difference in the uniting points of such pressures, between such structure and those of the defendants, is a material or substantial difference.

Objected to, as implying a total misunderstanding of the substance of the testimony of defendants' witnesses on the point referred to—their testimony, in substance, being that the fact that valve 22 admitted both the auxiliary-reservoir air and the train-pipe air to the brake-cylinder, evidenced a totally different construction and mode of operation of the apparatus from that shown in complainants' patent No. 360,070; and they not having testified that the mere fact that the air from the two sources referred to united at one point or another point, considered by itself, made any substantial difference in the result.

A. The two pressures, viz. auxiliary-reservoir and train or brake pipe pressure, unite, in the mechanism illustrated in patent 360,070, in the chamber 47 shown in Fig. 5 of that patent, where they commingle and enter the passageway designated 48 in such figure, and thence pass into the brake-cylinder.

In my opinion, it is wholly immaterial and not of the slightest consequence whatever, at which point the two pressures, viz., auxiliary reservoir and train or brake pipe pressure, unite to
237 enter the brake-cylinder, so long as they unite under conditions which permit them to readily enter such cylinder, by reason of such point being in open communication therewith.

The essential thing, so far as the uniting of the two pressures is concerned, is, as I understand the matter, that they shall unite at some point where the conditions are such that they can readily enter the brake-cylinder, owing to the fact that such point is in open communication with such cylinder, and, so long as this is the case, it is wholly immaterial, and not of the slightest consequence whatever, whether such pressures unite in the chamber 47, as is the case in the mechanism illustrated in the patent in suit, or that they unite in the chamber C of said defendants' valves.

It is true that, in said defendants' valves, there are valves 22 which can close communication, under certain circumstances, between such chambers C and their respective brake-cylinders, but, notwithstanding this fact, said chambers C are as much in open communication with their respective brake-cylinders, at the only

time that train or brake pipe and auxiliary reservoir pressure ca unite to enter such brake-cylinders, upon making an emergency quick-action application of the brakes, as is the case with t chamber 47 of the mechanism illustrated in the drawings of t patent in suit, and, so long as this is the case, the difference in t points at which brake or train pipe and auxiliary reservoir pres ures unite to enter their respective brake-cylinders, in the case said defendants' valves and the mechanism illustrated in the dra ings of the patent in suit, is, in my opinion, an immaterial and r substantial difference.

It will be remembered that in my former deposition I place upon plate IX of defendants' 1889 catalogue, the same letters, cha acters, and series of arrows which I used or placed upon plate X of defendants' 1891 catalogue. Because of this fact, I have used th same designating letters, in the present answer, that are foun upon the said two exhibits, and have therefore considere
238 both of the valves together in the present answer, the sligh difference in construction between the two valves bein wholly immaterial, so far as the present answer is concerned.

The two defendants' valves referred to are the valves which have heretofore, in my former deposition, termed "defendant 1889 quick-action brake-valve" and "defendants' 1891 quick-actio triple valve."

For convenience, I will hereafter, throughout my deposition, wher the difference in specific construction of the parts is not materia in my opinion, to the answers to be made, treat the two exhibits a one, and term them "defendants' quick-action triple valves."

200 Q. To what extent, if at all, is the existence of the partitio 9 material, in defendants' quick-action triple valves of defendants 1889 and 1891 catalogues?

A. I believe that the part, in the mechanism shown in plate IX of defendants' 1889 catalogue, which corresponds to the partition 9 of plate XI of defendants' 1891 catalogue, was not marked by m at the time that I made the other markings heretofore referred to and therefore I will, at this time, mark said partition, in plate IX of defendants' 1889 catalogue, with the numeral 9, so that it may correspond in marking with the corresponding partition in plate XI of defendants' 1891 catalogue.

The partition 9, of said defendants' quick-action triple valves is material and essential in said quick-action triple valves, as well as in every other quick-action triple valve with which I am acquainted, including, of course, the one shown in the patent in suit.

The said partition 9 is the means by which a restricted or small port or passage is made between the auxiliary reservoir and the brake-cylinder, so that auxiliary reservoir air or pressure is restricted or retarded in its movement or passage from the auxiliary reservoir to the brake-cylinder, when a quick-action or emergency application of the brakes is to be made, so that the restricting or retarding action of such restricted port or passage, permits the lower brake or train pipe pressure to readily pass into the brake-cylin-
239 der, notwithstanding the fact that the higher auxiliary

reservoir pressure is at the same time also entering the brake-cylinder.

This partition, and restricted passage or port, is necessarily located, relatively to the auxiliary reservoir and the triple-valve piston, so that such piston is open to auxiliary reservoir pressure, as in ordinary or plain triple valves, and can be acted upon by such auxiliary reservoir pressure on one side, and train or brake pipe pressure on the other, as in the case of such plain triple valves, as the same existed prior to the year 1887.

This restricted port or passage so restricts or retards the passage of auxiliary reservoir pressure, that notwithstanding the fact that such pressure is higher than that of the train-pipe, its volume is restricted, so that it, upon emerging from such port or passage, instantly expands and becomes lower in pressure than the train or brake pipe pressure, and it is owing to this sudden expansion of the auxiliary reservoir pressure, that the lower train or brake pipe pressure can enter the brake-cylinder in a comparatively large volume at the same time that the small volume of auxiliary reservoir air is also entering such cylinder. Of course, this only occurs when the two pressures unite to enter the brake-cylinder, upon a quick action or emergency application of the brakes, and the brake-cylinder is substantially free from pressure, and this only continues until the combined pressures in the brake-cylinder somewhat closely approximate the pressure in the brake or train pipe.

201 Q. What, if any, material or substantial difference is there, provided the air passes to the brake-cylinder, whether it all passes through one port (the port controlled by the valve 22), as in defendants' quick-action triple valves, or some of it passes through one port (22) and the remainder through another port (46) as in the structure of complainants' patent 360,070.

Objected to as immaterial and irrelevant, and not in rebuttal.

240 A. In my opinion it is wholly immaterial whether the fluid pressures pass through one port only, in order to reach the brake-cylinder, as in the case of said defendants' quick-action triple valves, or pass through two ports, as in the case of the quick-action triple valve illustrated in the patent in suit.

As I understand the matter, the essential thing, so far as the passage of the fluid pressure or compressed air from the auxiliary reservoir and the brake or train pipe to the brake-cylinder is concerned, is that the auxiliary reservoir pressure shall pass through a restricted port or passage as compared to the passageway through which the brake or train pipe pressure passes, and, so long as this is the case, it is wholly immaterial whether both pressures pass through only one port, as in said defendants' quick-action triple valve, or the auxiliary reservoir pressure passes through one port and the brake or train pipe pressure passes through another, as in the quick-action triple valve illustrated in the patent in suit.

This difference, the passage of both pressures through one port and their passage through two ports, is not a material or substantial

difference, so long as the essential conditions above named exist, as they do in the quick-action triple valves under consideration.

202 Q. Is the location of this restricted port or passage of any importance, and if so, to what extent?

Same objection.

A. It is not, so long as such restricted port or passage is located relatively to the brake-cylinder and the auxiliary reservoir so that the triple-valve piston is left in open communication with the auxiliary reservoir, to be acted upon by brake or train pipe and auxiliary reservoir pressures, as in plain triple valves as the same existed prior to the year 1887. This is the case with both the defendants' quick-action triple valves and the one shown in the patent in suit.

203 Q. As I understand the testimony of defendants' wit-
241 nesses, they apparently seek to represent that Mr. Boyden was the originator, in an apparatus of the class in question in this suit, of a passageway, controlled by a check-valve, from the train-pipe side of a triple-valve piston to the brake-cylinder side.

Have you examined the state of the art sufficiently to say whether or not Mr. Boyden is entitled to the credit of such a construction, at the date of his patent No. 280,285, June 26, 1883, in which it is shown. If he is not entitled to it, where is it previously to be found?

A. I have examined the state of the art sufficiently to enable me to state that such a passageway controlled by a check-valve, as referred to in the question, was not new or original with Mr. Boyden in his 1883 patent mentioned. Such a passageway and check-valve was old in the art long before the year 1883.

Such a passageway and check-valve is found in British letters patent, No. 3,000 of 1879, and also in United States letters patent to Perkins, No. 163,242, dated May 11, 1875, and to Jones, No. 166,386, dated August 3, 1875.

Mr. Church, one of defendants' experts, in his answer to question 10, after referring to the prior art generally, says, at folio 816 (D. R.), as follows:

"It was also common to employ a check-valve for the feeding-in valve, similar to the check-valve 26 (or 11), said check-valve being carried by the piston, as in defendants' valve. This feature is shown in the Westinghouse patent No. 144,006; Perkins No. 163,243, Jones No. 166,386, and Boyden No. 280,285."

It will thus be seen that according to Mr. Church, one of defendants' experts, at least three different United States patents show such a passageway and check-valve, prior to Mr. Boyden's 1883 patent No. 280,285. It will also be seen that, according to Mr. Church,
242 the specific form of passageway and check-valve shown in one of the figures of Mr. Boyden's 1883 patent, and also in said defendants' quick-action triple valve, is found in the art prior to Mr. Boyden's 1883 patent—that is, a passageway from the train-pipe side of a triple-valve piston to the brake-cylinder side thereof, which passageway is directly through the triple-valve piston itself, and the

check-valve carried by such piston, and which controls such passageway, was found in at least three United States patents which preceded in date the Boyden 1883 patent referred to in the question.

Furthermore, an examination of the several patents specifically named by me, will show that both of the specific forms of construction of such passageway and check-valve shown in Mr. Boyden's 1883 patent, were old in the art at least several years before 1883.

From the above it will be seen that Mr. Boyden is not entitled to the credit of originating the specific form of passageway and check-valve found in defendants' quick-action triple valve, at the date of his 1883 patent, and some years prior thereto.

An examination of the said Jones patent No. 166,386 discloses the fact that the passageway directly through the piston, controlled by the check-valve carried by such piston, found in said defendants' quick-action triple valve, resembles in proportions the passageway and check-valve of said Jones patent more nearly than it does the passageway and check-valve shown in figure 5 of said Boyden 1883 patent No. 280,285.

The above answer is objected to by defendants' counsel as not in rebuttal.

Counsel for complainants offers in evidence a printed Patent Office copy of the Perkins patent referred to by the witness in the last preceding answer, and the same is marked "Complainants' Exhibit Perkins Patent."

243 Also a printed blue-book copy of British patent No. 3,000 of 1879, and the same is marked "Complainants' Exhibit British Patent 3,000 of 1879."

The introduction and use of said exhibits are objected to at this stage of the proceedings, as not being in the nature of rebutting evidence, nor pertinent in answer to anything testified to by defendants' witnesses.

Adjourned to Saturday, November 25, 1893, at 10.30 a. m.

NEW YORK, *November* 25, 1893—10.30 a. m.

Met pursuant to adjournment.

Present: Counsel as before.

Deposition of HENRY F. NEWBURY resumed:

204 Q. Mr. Boyden appears to be of the opinion, as stated at the bottom of page 21 (D. R.), that he was the first to provide, as in his 1883 patent No. 280,285, "a single valve H arranged to govern a port through which the air pressure from the main air pipe and the air pressure from the auxiliary reservoir both passed to the brake-cylinder," and he apparently presents this statement in such a way as to imply that he thereby invented something which was of importance in the development of the quick-action triple valve.

Please state whether or not there was anything, in this feature of the Boyden patent No. 280,285 of 1883, which tended to aid in the development of the quick-action invention.

POOR COPY

Objected to as not correctly stating the meaning of Mr. Boyden, which was that the invention of said valve was of importance
244 in developing the quick-action triple valve operating on the principle of the defendants' brake mechanism.

A. There is nothing, so far as I can find in the Boyden patent No. 280,285 of 1883, which, in any way whatever, aided, or tended to aid, in the development of the quick-action triple valve, in any of the forms that it exists today, so far as I am acquainted with such valves. The specification of the said Boyden patent, which for convenience I will hereafter refer to as the Boyden 1883 patent, confirms me in the above opinion. The object of the invention of the said Boyden 1883 patent is therein set forth in the following words:

"The objects of the invention are, first, to provide for replenishing, while the brake is on, the air reservoir of each car or the brake-cylinder when the pressure therein has been released by leakage, and to accomplish this through a single line of train-pipe and by means which shall at all times be wholly under the control of the engineer, and also to provide for the more rapid charging than heretofore of the air reservoir on the car, and also to obviate the necessity of applying the brakes with such a high pressure as heretofore was necessary with the automatic brake, the effect of which is to slide the wheels and flatten them; second, to provide for dispensing with the main air reservoir on or near the locomotive, and thereby simplify and cheapen the apparatus; third, to provide for the quicker release of the brake."

I think that it is manifest that, by no possible means, could an apparatus designed with the above-named object in view, aid, or tend to aid, in the development of the quick-action invention, because it will be seen at once that there is not a single thing contained in the above quotation which even hints at or suggests the *quicker* application of the brakes.

245 An examination of the apparatus shown and described in the said Boyden 1883 patent, discloses the fact that by no possible means can any train or brake pipe pressure pass through or by the triple-valve piston, so as to commingle with the auxiliary reservoir air in the valve chamber of such 1883 mechanism, when the valve H has opened the port or passage to the brake-cylinder, except after the brakes have been fully applied, or applied with their full maximum force, and, in addition to this, the air pressure has leaked out from the brake-cylinder and auxiliary reservoir to a considerable extent, so as to reduce the force with which the brakes are applied to the wheels of the car.

I am unable to see how anything in an apparatus of this character, could in any way aid, or tend to aid, in the development of the quick-action invention, which is the quickening of the action of each succeeding triple valve by the venting of the train-pipe at or near the first quick-action triple valve, so that, instead of the train or main air pipe pressure having to travel from the rear of the train to the locomotive, to escape to the atmosphere, it can escape

at each quick-action triple valve, and thus save the time in the bringing into operation of the succeeding triple valve.

A further examination of the said Boyden 1883 patent discloses the fact that no main air or train pipe pressure can pass through or by the triple-valve piston, after the brakes have been applied with their full maximum force, until the equalized pressure in the auxiliary reservoir and brake-cylinder has been reduced by leakage below the pressure existing in the supplemental air chamber, designated in such Boyden patent as L. Also, that the brakes cannot be held against the car wheels after they are first applied by the equalization of the pressures in the auxiliary reservoir and brake cylinder with the same or equal force, owing to the fact that the pressure in the supplemental chamber or reservoir L of that patent expands, and, furthermore, there is necessarily a leak-
246 age in the piston which closes that chamber from the balance of the mechanism, the same as there would be from the auxiliary reservoir and brake-cylinder, therefore, the equalized pressures in the brake cylinder and auxiliary reservoir when the brakes are first applied, cannot be attained by the passage of train or main air pipe pressure through or past the triple-valve piston of that mechanism.

These facts disclose nothing which, in my opinion, would in any way tend to aid in the development of the quick-action invention, and, if anything, they would tend to lead one away from that invention.

The art prior to Mr. Boyden's 1883 patent, discloses a triple-valve mechanism containing a single valve, of the sliding type, which controls the port or passage to a brake-cylinder through which air from the main air or train pipe can pass directly into the auxiliary reservoir and brake-cylinder by passing into the valve chamber containing the valve which controls the port or passage leading into the brake-cylinder. Such a mechanism with such a single valve, is shown in the British patent No. 3000 of 1879.

Notwithstanding this fact, I do not understand that any one asserts that the presence, in the art, of said British patent, in any way tended to aid in the development of the quick-action invention.

Mr. Boyden, in his answer to Q. 8, folio 84 (D. R.) admits that the said 1883 Boyden patent was not for a quick-action valve, as that term is now understood.

All of the above-named facts confirm me in the opinion heretofore expressed in this answer, that there is nothing whatever in the said Boyden 1883 patent which in any way tended to aid in the development of the quick-action invention.

The foregoing answer is fu-ther objected to by defendants' counsel, as not in the nature of rebutting evidence.

205 Q. Defendants' witnesses have much to say about
247 "differential pressures" and "momentary differential pressures," and they seem to be of the opinion that Mr. Boyden was the first to originate or construct a quick-action triple valve

operating in that way. Please state whether or not this element of operation of a quick-action triple valve was new with Mr. Boyden, and if not, where previously it is to be found?

A. The element of "differential pressures" and "momentary differential pressures" is not new and original with Mr. Boyden, as I understand the use of those terms by defendants' witnesses.

"Differential pressures" and "momentary differential pressures," as I understand the use of such terms by defendants' experts, are pressures which differ in degree, in different parts of a quick-action triple valve, at different periods or moments of time, when a quick-action or emergency application of the brake is made. Such momentary differences in pressure in different parts of the quick-action triple-valve mechanism, permit the lower brake or main air pipe pressure to enter the brake-cylinder, notwithstanding the fact that the higher auxiliary reservoir pressure is also at the same time allowed to enter such brake-cylinder.

These momentary differential pressures are caused by retarding or restricting the flow of the auxiliary reservoir pressure into the passageway where it unites with the brake or main air pipe pressure. Such restricting or retarding action upon the flow of auxiliary reservoir pressure, permits the pressure, as it escapes from the restricted port or opening in the partition between the brake-cylinder and the auxiliary reservoir, to instantly expand as it passes through such port or opening into substantially free and open communication with the brake-cylinder, which, at this time, is substantially free from pressure. Such expansion of the auxiliary reservoir pressure reduces it much below the pressure in the main air or train pipe, so that the pressure from this pipe can enter the brake-cylinder in large volume, up to the time that the pressure which has entered the brake-cylinder approximates the pressure in
248 the brake or train pipe. This approximation in pressure between the brake-cylinder and the main air or train pipe, of course, prevents further passage of pressure from the latter to the former.

Of course all plain triple valves, or what are sometimes termed triple valves proper, depend upon momentary differential pressures for their operation, that is, the difference in pressure at different moments of time upon the opposite sides of the triple-valve piston, but I do not understand that defendants' experts refer to these differential pressures when they use the term as they have done.

"Differential pressures" and "momentary differential pressures," as these terms have been used by defendants' experts, refer, as I have heretofore explained, to the momentary differences in the pressures in different parts of a quick-action brake mechanism, when a quick action or emergency application of the brakes is to be made, and such "differential pressures" and "momentary differential pressures" exist in every quick-action brake mechanism with which I am acquainted, including, of course, the one shown in the patent in suit, and also those which preceded in date defendants' quick-action triple valves illustrated in plate IX defendants' 1889 catalogue and plate XI of defendants' 1891 catalogue.

Such "differential pressures" and "momentary differential pressures" are first found in the mechanism shown in the patent in suit, and, therefore, they were new and original with Mr. Westinghouse, and not with Mr. Boyden, as said defendants' witnesses seem to assert.

The partition with the restricted port or opening, located between the auxiliary reservoir and the brake-cylinder, and by means of which the "differential pressures" or "momentary differential pressures" are caused in the quick-action triple valve shown in the patent in suit, consists of the walls of the triple-valve piston bushing, designated as 24 in figure 2 of the patent in suit, and the balance of the casting or metal between such piston chamber
249 and the brake-cylinder, with a portion of the slide-valve 14, which slide-valve contains the restricted port or opening designated 35. The specification of the patent in suit described this restricted port or opening 35, and the size of the same, as follows:

"The feed-opening for the admission of air from the auxiliary reservoir to the brake-cylinder is purposely made of comparatively small diameter, it having been determined by experiment that the initial application of the brake should not be made with maximum force, and this opening may be made of such size and to apply the brake exactly in accord with the requirements of the most efficient work."

"The initial application of the brakes" referred to in the above quotation, I understand to be the first or initial portion of the application of the brakes, when making a quick action or emergency application, or, in other words, it refers to that portion of a quick action or emergency application, wherein brake or main air pipe pressure is admitted to the brake-cylinder, of course including whatever auxiliary reservoir air or pressure which may enter the brake-cylinder during the time that the main air or train pipe pressure enters it.

The specification of the patent in suit describes the passage leading from the main air or train pipe to the brake-cylinder, and into which auxiliary reservoir pressure expands, as it passes through the restricted port or opening 35 to enter the brake-cylinder, as

"A passage of considerable size open from the brake-pipe on each car, whereby the pressure is more quickly reduced, but the air so discharged is utilized in the performance of preliminary work, it being found in practice that the air so taken from the pipe will exert a pressure of about twenty-five pounds in the brake-cylinders."

This construction of the passageway leading directly from
250 the main air or train pipe to the brake-cylinder, of considerable size, and the making of the port 35 of comparatively small diameter, necessarily produces momentary differential pressures, whenever a quick action or emergency application of the brakes is to be made.

Because of these facts Mr. Boyden was not the first to originate or construct a quick-action triple valve operating so that "differential pressures" and "momentary differential pressures" take

place, and, so far as I know, the first time that a quick-action triple valve operating in this way appears in the art, is in the patent in suit, and Mr. Westinghouse was the first to originate and construct such a quick-action triple valve.

The foregoing answer is objected to by defendants' counsel as not in rebuttal.

206 Q. Please state what you understand to be the distinguishing characteristics of a "triple valve," as known in the art of railroad air brakes prior to 1887, with special reference to the several functions of such appliance or device.

A. The distinguishing characteristics or functions of a triple valve, as I understand the matter, are three in number, as the same existed prior to 1887.

First, controlling the admission of compressed air or fluid pressure from the main air or brake pipe to the auxiliary reservoir.

Second, controlling the admission of auxiliary reservoir pressure to the brake-cylinder, to apply the brake and,

Third, controlling the exhaust, or releasing a brake-cylinder pressure to the atmosphere, to release the brake.

The above are the distinguishing characteristics of triple valves, as the same existed prior to the year 1887, as I understand the matter.

251 The patent in suit describes triple valves, as they existed prior to the invention of the quick-action system, as follows:

"In using the terms 'triple valve' and 'triple-valve device' I refer to a valve device, however specifically constructed, having a connection with the main air or brake pipe, another with an auxiliary reservoir or chamber for the storage of power, and another with a brake-cylinder or its equivalent for the utilization of the stored power and with a release or discharge passage for releasing the operative power from the brake-cylinder, whether the valves governing these passages or connections are arranged in one or more cases and are moved by a piston or its equivalent, or by a series of pistons or their equivalents, there being numerous examples in the art of construction varying materially in appearance whereby these functions are performed, both in plenum and vacuum brake mechanism."

Two of defendants' exhibits herein, viz., the Boyden patents Nos. 481,134 and 481,135, define "triple valves." The definition in both of these patents, I believe, is in the same language, there being a variation of one word, which does not in any way alter the sense. I will quote from Defendants' Exhibit Boyden Patent No. 481,134, quoting the entire paragraph in which the definition of triple valves is found, commencing at line 111 and ending at line 127 of page 4 of that patent:

"As hereinbefore intimated, this valve mechanism belongs to the class of air-brake valves known as 'triple valves' of which there are numerous examples, differing somewhat in construction and embodying variations and modifications in the form and arrange-

ment of parts; but all of them, however specifically constructed, contemplate a valve structure having suitable connections for the train-pipe, the auxiliary reservoir, and the brake-cylinder,
252 and are provided with passages or ports leading, first, from the train-pipe to the auxiliary reservoir; second, from the reservoir to the brake-cylinder, and, third, from the brake-cylinder to the atmosphere; hence the name triple valve. In some cases a plurality of valves govern these passages or ports."

Mr. Church, one of defendants' experts, in his answer to Q. 5, after referring to the old-style straight air or non-automatic system of brakes, then refers to the automatic system, which is a system by the use of which the brakes are self-applied, upon the breaking in two of the train or an accident occurring to the main air or train pipe by which it is ruptured, and the air, which is constantly maintained in such pipe, is allowed to escape. After briefly describing the automatic system, and the valve mechanism by which the compressed air or fluid pressure is controlled to do this work, he says:

"The mechanism through which this result or effect is produced and made possible is known as a 'triple valve' for the reason that it is arranged to control or effect three distinct lines of communication, one between the train-pipe and reservoir, through which the reservoir is charged with air under pressure; a second between the brake-cylinder and the atmosphere, through which the air is exhausted or allowed to escape when the brakes are released; and a third between the auxiliary reservoir and the brake-cylinder, through which the air is conducted for actuating the brakes."

From the above, it will appear that Mr. Church, one of defendants' experts, Defendants' Exhibit Boyden Patents, the patent in suit, and myself, all agree as to what are the distinguishing characteristics of a triple valve as known in the art of railroad
253 air brake prior to 1887, and the several functions of such valve as then known.

207 Q. So far as the means of admitting pressure from the auxiliary reservoir to the brake-cylinder are concerned, in triple valves as known prior to 1887, what was the only essential consideration structurally in that regard?

A. The only essential consideration, structurally, so far as concerns the admission of auxiliary reservoir pressure to the brake-cylinder, in triple valves as they existed prior to 1887, was that the valve should be constructed to uncover the port or passage leading from the auxiliary reservoir to the brake-cylinder sufficiently to allow of such pressure expanding into the brake-cylinder to apply the brakes.

208 Q. How many valve-controlled ports, passages or channels, for the traverse of air under pressure from the auxiliary reservoir to the brake-cylinder, were required in a valvular appliance known prior to 1887, in order to enable it to be fully and truly a "triple valve"?

A. One only was all that was necessary.

209 Q. To what extent, if at all, would the addition of one or

more passages for reservoir air to the brake-cylinder, to the one which you say is all that is necessary, bear upon the question of whether or not the valvular appliance was what was termed a "triple valve" prior to 1887?

A. The addition of one or more passages or ports for the admission of auxiliary reservoir air to the brake-cylinder to the one referred to by me, would not, in any way, necessarily change such valvular appliance, and the same would still be termed a triple valve, as it was known prior to 1887.

210 Q. Defendants' witnesses seem to be of the opinion, or to desire to have the inference drawn from what they say, that if the valve 22, of defendants' quick-action triple valves, was fastened to its seat, said structures would not be triple valves at all, as
254 the term "triple valve" was used prior to 1887. What are the facts in this regard?

Objected to as embodying an erroneous assumption.

A. Defendants' triple valves, with the valve 22 fastened to its seat, so that it forms, in effect, simply a partition through which the triple-valve piston stem moved and formed a passage or port for the admission of auxiliary reservoir air to the brake-cylinder, would still be triple valves proper, or, as more generally termed, plain triple valves, notwithstanding the fact that the valve 22 was so fastened to its seat.

Defendants' quick-action triple valves, when the valve 22 was fastened to its seat, as stated in the question, would be triple valves, as that term was used prior to 1887, because they would then be capable of performing every function called for in triple valves at that date, and would also be capable of performing the functions of triple valves as defined by Mr. Church, in the said two Boyden patents, the patent in suit, and myself, and they would be as capable of performing all those functions, when the valve 22 was fastened to its seat, as they would be in the condition before the fastening of the valve to its seat occurred.

Furthermore, said defendants' quick-action triple valves, with the valve 22 fastened to its seat, would be, in the language of defendants' expert, Mr. Church, "arranged to control or effect three distinct lines of communication, one between the train-pipe and reservoir, through which the reservoir is charged with air under pressure; a second between the brake-cylinder and the atmosphere through which the air is exhausted or allowed to escape when the brakes are released; and a third between the auxiliary reservoir and the brake-cylinder, through which the air is conducted for actuating the brakes."

255 This would be as true with said defendants' quick-action valve, when the valve 22 was fastened to its seat, as it would be when such was not the case.

These three distinct lines of communication, as defined by Mr. Church, and when the valve 22 was fastened to its seat in defendants' quick-action valve, will be found graphically pointed out in Defendants' Exhibit Illustrative Cuts.

The first distinct line of communication, that is, the one between the train pipe and auxiliary reservoir through which the auxiliary reservoir is charged with air under pressure, will be found indicated by a red line in drawing No. 2 of such illustrative cuts.

The second distinct line of communication, that is, the one between the brake-cylinder and the atmosphere, through which the air is exhausted or allowed to escape when the brakes are released, will be found indicated by a yellow line in the same drawing of such illustrative cut.

The third distinct line of communication, that is, the one between the auxiliary reservoir and the brake-cylinder, through which the air is conducted for actuating the brakes, will be found indicated by a red line in drawing No 4 of such illustrative cut.

By actual test, with a mechanism the same as said defendants' quick-action triple valves shown in plate XI of defendants' 1891 catalogue, except that a permanent partition was substituted in the place of the valve 22, so that by no possibility could there be any admission of fluid pressure through such partition, except as it passed through the port or passage in the stem of the triple-valve piston, as shown in said drawing No. 4 of defendants' illustrative cuts, I found that the mechanism of this character performed all of the functions of a triple valve proper as the same were known prior to 1887. These tests I repeated many times and always with the same results.

Some of the tests were made with this mechanism alone, and others were made where this mechanism was coupled up with some of the new Westinghouse quick-action triple valves, and I
256 found with the mechanism, like said defendants' quick-action triple valve, with the permanent partition substituted for the valve 22, that as a matter of fact, so far as applying the brakes was concerned, except for a quick action or emergency application, there was no substantial difference between the operation of this mechanism as a triple valve proper and such new Westinghouse quick-action triple valves.

Furthermore, I have made repeated tests with a quick-action triple valve the same as shown in plate XI of defendants' 1891 catalogue, with glass windows in, so that the operation of the valve 22 could readily be observed, and in such case, although the tests were repeated many times, and every effort made to unseat the valve 22, when such apparatus was used as a triple valve proper, in every case the valve 22 remained seated until every function of a triple valve proper was served, that is, until the compressed air or fluid pressure in the brake-cylinder and auxiliary reservoir had equalized, and applied the brake with the full approximate force of the auxiliary reservoir pressure.

Of course, after the pressures in the auxiliary reservoir and brake-cylinder had equalized, and applied the brakes to the full maximum power of the auxiliary reservoir pressure to apply them, the valve 22 could be unseated, but when this occurred there was no function whatever of a triple valve proper to be served as such functions had been fully served before the unseating of the valve 22 occurred.

In attempting to unseat the valve 22 in these tests, before the full functions of a plain triple valve, or triple valve proper, as the same was known prior to 1887, were served, the valve 22 was repeatedly unseated, but, in each case, before such functions of the triple valve proper were served, the pressure from the train or brake pipe entered the brake-cylinder, to a greater or less extent, as we approached the point where the full functions of such triple valve proper were served. This fact, that train or main air pressure entered the
257 brake-cylinder, was demonstrated by the action of a pressure
gauge connected with the main air or train pipe side of the piston. In all of the foregoing tests, the auxiliary reservoir and brake-cylinder were also provided with pressure gauges, so that the pressures in such reservoirs and brake-cylinders could be read.

The above facts and tests compel me to the opinion that the valve 22 of defendants' quick-action triple valves is no part or portion of the triple valve proper, and is as useless in said defendants' quick-action triple valves, as a portion of the triple valves proper of those mechanisms, as a pocket would be for a toad to put his tail in.

211 Q. In defendants' illustrative cuts 2 and 4, which, as you have stated in your last preceding answer, show the three distinct lines of air communication as defined by Mr. Church, is the valve 22 shown as seated or unseated?

A. In each case this valve 22 is shown as seated.

212 Q. And how does the position of the parts, as shown in these two cuts, in effecting these three several lines of air communication, compare with the conditions which would obtain if the valve 22 was fastened to its seat?

A. They are identically the same as would be the case if the valve 22 was fastened to its seat, or a permanent partition was substituted for the same, as before described by me.

213 Q. I also understand defendants' witnesses to endeavor to show, argumentatively, that defendants' valve 22 is not an "auxiliary" valve, within the meaning of the claims of complainants' patent 360,070 in suit.

Please state your understanding of the essential requirements of an "auxiliary" valve, as that term is used in the art of quick-action air brakes, and as referred to in the claims of patent 360,070, and state also to what extent, and how, the defendants' quick-action triple valves comply with such requirements.

258 A. I understand that the essential requirements of an
auxiliary valve, as that term is used in the art of quick-action air brakes, and as referred to in the claims of the patent in suit, to be as follows:

(1) That such valve is to be associated with another valve, which, in normal action, performs the functions of admitting and releasing auxiliary reservoir pressure to and from the brake-cylinders, and also with a valve admitting main air or train pipe pressure to the auxiliary reservoir.

(2) That such valve is arranged in a prescribed relationship to a passageway, port, or conduit, leading from the train or main air

pipe to the brake-cylinder, whereby it opens such passageway, port, or conduit, under abnormal conditions of use.

The said defendants' quick-action triple valves contain a valve known as valve 22, which complies with the above named requirements, as fully, and to the same extent, that the valve 41 of the mechanism shown in the patent in suit complies with such requirements.

That is, the valve 22 of said defendants' quick-action triple valves is associated with another valve (in my former deposition designated as main valve 17–18) which, in normal action or operation, performs the functions of admitting and releasing auxiliary reservoir pressure to and from the brake-cylinder, and also with the valve admitting main air or train pipe pressure to the auxiliary reservoir.

Again, the said valve 22 is arranged in a prescribed relationship to a passageway, port, or conduit leading from the main air or train pipe to the brake-cylinder, whereby it opens such passageway, port or conduit under abnormal conditions of use.

This passageway, port, or conduit, in said defendants' quick-action triple valve, is illustrated in drawing No. 8 of said defendants' illustrative cuts, and is there indicated by a blue line extending from the main air or train pipe to the brake-cylinder.

Adjourned to Monday, November 27, 1893, at 10.30 a. m.

259 New York, *November* 27, 1893—10.30 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of Henry F. Newbury resumed:

(Answer to Q. 213 continued:) It is true that the valve 22 of said defendants' quick-action triple valves can be opened when a quick-action or emergency application of the brakes is not made, but notwithstanding this fact, the valve 22 is not necessary to any of the functions of a triple valve proper, and is associated with another valve mechanism which does perform all the functions of a triple valve proper, or, as more generally termed, a plain triple valve, as such functions have heretofore been set forth. Also the valve 22 is arranged in a certain way, or in a prescribed relationship to, a passageway, port, or conduit, leading directly from the train or main air pipe to the brake-cylinder, whereby it opens such passageway, port, or conduit, under abnormal conditions of use, such as in making a quick-action or emergency application of the brakes.

In all these respects, the valve 22 is as much an auxiliary valve as is the valve 41 of the mechanism shown in the patent in suit.

If the statement contained in defendants' 1891 catalogue is true, and Mr. Boyden, in his answer to X Q. 204, admits that it is, then the results accomplished by the said defendants' valve, as well as the actions while accomplishing such results, are the same as in the new Westinghouse quick-action triple valve, with which said defendants' valves are made interchangeable.

This statement in defendants' 1891 catalogue is as follows:

"The actions of this valve (defendants' quick-action triple valve in graduating, full service application, quick action and release, are the same as the new Westinghouse quick-action valve, thereby
260 producing the same results in braking, which renders cars equipped with the two valves perfectly interchangeable the hose couplings being the same."

So long as the above statement is true, it is manifest, I think, that the valve 22, of said defendants' quick-action triple valves, must perform all the work of the auxiliary valve shown in the mechanism illustrated in the patent in suit, and also perform such work in the same way. Therefore, the valve 22 is necessarily an auxiliary valve, and a part of the quick-action portion of said defendants' quick action triple valves, and not a part of the triple valves proper of those quick-action triple valves.

214 Q. As I understand the views expressed by defendants' witnesses Boyden and Church, and more particularly summed up on page 28 (D. R.) by Mr. Boyden, they seek to make it appear that the port 35, near the outer or extreme end of the valve 14 of patent 360,070, is the "main" valve of that mechanism, and therefore is a part of the "triple valve proper," as distinguished from a quick-action attachment.

If there is any error or fallacy in such presentation of the facts, please point it out.

A. In my opinion, defendants' witnesses are in error in such presentation of the facts, and any statement which would necessarily make the port 35, of valve 14, a portion of the triple valve proper, of the mechanism shown in the patent in suit, instead of a part of the quick-action portion of that mechanism, is untrue, and against the statement of the patent in suit.

The specification of the patent in suit, at lines 4 to 19, on page 3 thereof, reads as follows:

"The construction and relative arrangement of the piston stem 13, slide-valve 14 and graduating valve 29, are substantially similar to those of the corresponding parts as heretofore employed by me and exemplified in my letters patent No. 220,556; but under
261 my present invention these are supplemented by a port 35, leading from the end of the valve adjacent to the opening of the chamber 24, which communicates with the auxiliary reservoir, to the face of the valve, so as, at the limit of traverse of the piston stem, in the application of the brake, to establish communication directly through said passage between the auxiliary reservoir and the port 23 and passages 22 and 16, leading to the brake-cylinder."

This statement of the specification of the patent in suit shows that the port 35 is supplemental to those portions of the mechanism which go to make up the triple valve proper of the quick-action triple valve shown in the patent in suit, and therefore, that it must be a part of the quick-action portion of that mechanism, which is contrary to the views of said defendants' witnesses, as particularly summed up on page 28 (D. R.) by Mr. Boyden, wherein he makes

the port 35 the main valve of the mechanism shown in the patent in suit.

The statement just heretofore quoted from the specification of the patent in suit, immediately follows a description of that portion of the mechanism which performs the ordinary functions in braking and which is designated in the patent in suit as "the triple valve proper 10" of that mechanism.

The specification of the patent in suit uses the following language, found at lines 29 to 51, page 2, thereof:

"So far as the performance of its preliminary function in ordinary braking is concerned—that is to say, effecting the closure of communication between the main air pipe and the auxiliary reservoir, and the opening of communication between the auxiliary reservoir and the brake-cylinder in applying the brakes, and the reverse operation in releasing the brakes—the triple valve 10 accords substantially with that set forth in letters patent of the United States No. 220,556, granted and issued to me October 14,
262 1879, and is not, therefore, saving as to the structural features by which it performs the further function of effecting the direct admission of air from the main air pipe to the brake-cylinder, as presently to be described, claimed as of my present invention. Certain of its elements devised and employed by me prior thereto will, however, be herein specified, in order to render its construction and operative relation to other members of the brake mechanism fully intelligible."

Then follows the description of the triple valve proper of this mechanism, after which follows the quotation first made in this answer. After the said first quotation follows a description of the means by which "the direct admission of air from the main air pipe to the brake-cylinder" is accomplished.

These statements compel me to the opinion that the port 35 is supplemental to the main valve of the triple valve proper of the mechanism shown in the patent in suit, and therefore, is no part or parcel of such triple valve proper, but is, in fact, wholly for, and a part of, the quick-action portion of that mechanism, and that said defendants' witnesses are wholly in error, in attempting to make it appear that such port 35 is a portion of the triple valve proper of the mechanism shown in the patent in suit.

The statements found in the above quotation would seem to make it manifest that the prior Westinghouse patent No. 220,556 is not sufficient warrant for attempting to make it appear that the port 35 is the main valve of the mechanism shown in the patent in suit, and, as I understand the testimony of said defendants' witnesses, this prior Westinghouse patent is the only warrant they find for asserting, or attempting to make it appear, that the port 35 is the main valve of the mechanism shown in the patent in suit.

The only place in the patent in suit where I find the term
263 "main valve" is in the first and last claims thereof, and such term is nowhere found in the descriptive portion of the specification of such patent.

In this last or 7th claim of the patent in suit, the term "main

valve" is therein defined or described by its functions, and, furthermore, the port 35 is therein made supplemental to such main valve, as will fully appear by the reading of such claim, which is as follows:

"7. The combination, in a triple-valve device, of a case or chest, a piston fixed upon a stem and working in a chamber therein, an auxiliary valve actuated by the piston stem and controlling communication between passages leading to connections with a main air pipe and with a brake-cylinder, respectively, and a main valve connected to the piston stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere, respectively, said main valve having a supplemental port or passage which establishes communication between the auxiliary reservoir and brake-cylinder connection at or near the limit of the traverse of the main valve in effecting the application of the brake under maximum pressure, substantially as set forth."

The valve herein referred to as being connected to the piston stem and governing ports and passages in the case leading to connections with the auxiliary reservoir and a brake-cylinder and to the atmosphere, respectively, and called therein "a main valve," is the valve described in the descriptive part of the specification and therein referred to as the valve 14, which is connected to the piston stem 13, the latter of which is described therein as "carrying, as in my letters patent 220,556, before mentioned, a slide-valve, 14, which controls communication between the auxiliary reservoir and the brake-cylinder, and between the brake-cylinder and
264 release port 15, respectively." These words will be found at lines 64 to 70, of page 2, of the patent in suit.

These statements leave no doubt in my mind as to what the construction of the main valve of said claim 7 is, and also, that the port 35 therein referred to as "a supplemental port or passage which establishes communication between the auxiliary reservoir and brake-cylinder connections at or near the limit of traverse of the main valve in effecting the application of the brake under maximum pressure," is supplemental to such main valve, and is no part of the triple valve proper, but belongs wholly to the quick-action portion of the mechanism shown in the patent in suit.

The above statements, taken in connection with the descriptive portion of the specification, leave no doubt in my mind but that the main valve, referred to in claim 1 of the patent in suit, is also the main valve referred to in claim 7 thereof.

It will be observed that in claims 4, 5 and 6 of the patent in suit there is a valve defined or described, by functions, in the following language:

"A valve moving with the piston stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere respectively";

Which valve, so far as functions go, is identical with the valve termed in said claim 7 "a main valve," and, therefore, is substantially the same valve as that of claim 7.

It will also be observed that, in claims 4, 5 and 6, there is another ralve termed the "auxiliary valve," which, as stated in claims 4 nd 5, is "actuated by the piston stem and controlling communiation between passages leading to connections with a main air ipe and with the brake-cylinder, respectively," and in claim 6 as an auxiliary valve connected to the auxiliary stem and controlling ommunication between passages leading to connections with a nain air pipe and with the brake-cylinder, respectively," which auxiliary valve is manifestly auxiliary to the one before
265 referred to, which, therefore, is the *main valve* of those claims.

These facts also compel me to the opinion that defendants' witesses are wholly in error as to the port 35 being any part of the riple valve proper, and that such port is supplemental to the main alve, and, therefore, a part of the quick-action portion of the mechnism shown in the patent in suit.

215 Q. Wholly regardless of what opinion you may have, or what onclusion you may draw from patent No. 360,070, as to the *character* of, or nomenclature properly applicable to, the port 35 of said atent, will you please state, as a matter of fact, to what extent, if t all, it is physically possible for said port to perform any function vhatever, in any operation of the mechanism of said patent as a triple valve proper," that is to say, in any operation whatever ther than that of effecting the quick-action application of the rakes?

A. As a matter of fact, it is a physical impossibility for the port 5 to be opened, at any other time than when the auxiliary valve 1, shown in the patent in suit, is also opened, and it is also a physial impossibility for said port 35 to perform any function whatever, n any operation of that mechanism when it is used as a triple valve roper, and it is only brought into use when a quick-action or mergency application of the brakes is to be made.

Mr. Boyden in answer to X Q. 161, (fols. 464–5 D. R.) admits that is a physical impossibility to open the port 35 without opening he valve 41. His said answer is as follows:

"A. I will admit that I consider it a physical impossibility to pen the port 35 without opening the valve 41."

216 Q. I call your attention also to the statement of Mr. Boyden n page 30 (D. R.) that "this distinctly shows that the complainnts' device uses two valves to perform the quick application of the brakes, one of which belongs to the *triple valve proper*, while
266 the other is an *auxiliary valve additional* to the triple-valve structure."

To what extent do you agree with this statement, and others of ike tenor?

A. I do not agree with the statement contained in the question, r others of like import, which would imply that any portion whatver of the triple valve proper, or any valve which may be said to elong to the triple valve proper of the patent in suit, is used in naking a quick application of the brakes, if by such statement it s intended to assert that the port 35 is any portion of the triple

valve proper, that is, is any portion of the mechanism of the patent in suit which is essential or necessary in such mechanism, while it is serving the function of a triple valve proper, as such valve has been defined by defendants' witnesses both in their testimony and in the specifications of patents in evidence herein.

The two valves to which Mr. Boyden refers on page 30, (D. R.) are composed of the port 35 and the auxiliary valve 41 shown in the patent in suit, and, as before stated, with my reasons at length, this port and valve belong wholly to the quick-action portion of that mechanism and not to the triple valve proper. My reasons, I think, will be apparent from what I have heretofore said without again repeating them.

217 Q. I call your attention to Mr. Boyden's classification of valves and valve functions of patent 360,070 in suit, on page 29 (D. R.) under the head of "fifth valve." Please state whether you find Mr. Boyden's classification to be a correct one, and point out any erroneous or misleading statements therein, if there be such?

A. Mr. Boyden on said page, at folio 115, states that:

"The number of valves shown and described in complainants' patent No. 360,070 to perform the 'triple-valve' and 'quick-action' functions are five, four of which belong to the triple valve
267 proper, and the fifth or auxiliary valve is added to admit air from the main air pipe to the brake-cylinder."

I understand that these so-called five valves, four of which belong to the triple valve proper, as set forth by Mr. Boyden, refer to the classification which he had made in his deposition, just preceding the statement quoted by me, the four valves belonging to the triple valve proper being found on the preceding page of defendants' record, and the fifth one on the page referred to in the question.

In my opinion, Mr. Boyden's said classification of valves is incorrect and misleading. As I understand the matter, there is no warrant whatever for any classification which would make four of the five so-called valves named by Mr. Boyden, as belonging to the triple valve proper, and, furthermore, in my opinion, any classification which gave more than four functions or valves to the mechanism shown in the patent in suit would be erroneous, for, as I understand the matter, there are but four functions, or valve functions, of such mechanisms, which are as follows:

(1) A valve to control the admission of train or main air pipe pressure to the auxiliary reservoir, to charge the latter with compressed air.

(2) A valve for controlling the admission of auxiliary reservoir pressure to the brake-cylinder, to apply the brakes.

(3) A valve for exhausting or releasing brake-cylinder pressure to the atmosphere, to release the brakes; and,

(4) A valve controlling the admission of main air or train pipe pressure directly from such pipe to the brake-cylinder, for applying the brakes with great rapidity and maximum force.

The above four valve functions, or so-called valves, are all that is necessary or essential in a triple-valve mechanism capable of per-

forming the three classes of work referred to by me in my former deposition as "graduation," "service stops," and "emergency
268 stops," or as referred to by defendants' witnesses, Mr. Boyden and Mr. Church, as graduating, service stops, and quick-action applications of the brakes.

It is true that a classification which makes these so-called valves *five* in number can be made, but notwithstanding this fact, in my opinion, the said classification of Mr. Boyden is incorrect and misleading, because, while it is possible to make a classification in which there are five so called valves, yet only three of them can be said to belong to the triple valve proper of the mechanism shown in the patent in suit, which three would not include the port 35, which Mr. Boyden has termed the fourth valve of his classification, but such port 35 would belong wholly to the quick-action portion of the mechanism shown in the patent in suit.

I am confirmed in these opinions by the admission of Mr. Boyden, in his answer to X Q. 161 heretofore quoted, his statement in answer to R. D. Q. 237, which in substance is, that in a quick-action application of the brakes, if the port 35 was plugged up so that no air could pass through, it would practically destroy the efficiency of the brakes in making such quick-action application, and his answer to X Q. 152, wherein he admits that only four functions of the valve mechanism are recited in the description of the operation of the mechanism shown in the patent in suit, and that these four functions are as follows:

(1) To admit air from the main air pipe to the auxiliary reservoir.

(2) To admit air from the auxiliary reservoir to the brake-cylinder through the port controlled by the graduating valve 29, to apply the brakes in making ordinary stops.

(3) To exhaust air from the brake-cylinder to the atmosphere, to release the brakes, and ;

(4) To effect the admission of air directly from the main air pipe to the brake cylinder, to apply the brakes with great rapidity and with their greatest available force.

218 Q. What, if anything, do you find in the construction
269 and operation of the quick-action triple valve as described in patent 360,070, which would require or imply the port 35 to be used in ordinary braking, that is to say, if the quick-action operation was dispensed with, and the structure was used merely as a triple valve proper?

A. There is nothing whatever, so far as I can find, in the construction and operation of the mechanism shown in the patent in suit, No. 360,070, which would imply or require the port 35 to be used in ordinary braking, and when the quick-action operation, or emergency application of the brakes, was dispensed with.

If, for any reason, it was desired that the quick-action operation of the brakes be dispensed with, then a stop could be placed in the triple-valve piston chamber, designated in the patent in suit as 11, so that the valve 41 of that mechanism would never be moved sufficiently to open the port 42 of that mechanism, and, when this was

done, then the mechanism would perform every function of a triple valve proper, and perform each and all of such functions, in precisely the same way that it would perform them without such stop in the piston chamber, and the port 35 could, by no possibility, perform any function whatever, or in any way affect or influence any of the functions served by the portions of the mechanism which go to make up the triple valve proper.

Of course, it will be understood that so long as the valve 41 cannot open the port 42, the port 35 is entirely useless, as it cannot register with any part of the port or passage 23 leading to the brake-cylinder, which it can do when the port 42 is opened by the valve 41. In this connection, I will refer to Mr. Boyden's admission, in answer to X Q. 161, wherein he says that the port 35 cannot be opened without also opening the valve 41. The opening of the port 35 is only accomplished by bringing it in register with the port or passage 23 before referred to.

219 Q. Referring to the statement of defendants' 1891 catalogue, to the effect that defendants' quick-action triple valves are
270 interchangeable with the Westinghouse quick-action triple valves, and keeping in mind the theory of defendants' witnesses that the valve 22 of defendants' structures is made to work as a main valve in service stops by a careful manipulation of the engineers' valve, what does the fact of the interchangeability of the structures indicate to you, as regards their substantial identity for quick-action purposes, when made up in the same train and all worked by the ordinary Westinghouse engineers' valve. In other words, in a train so made up, and in ordinary use, would the Westinghouse engineers' valve make suitable provision for such careful manipulation as would tend to cause the valve 22 to act as a main valve, or will it always and invariably be a quick-action valve?

Objected to, in so far as the question involves the Westinghouse engineer's valve, for the reason that such valve is no part of the matter here in controversy, is not essential to the operation of the device in question, and is not the only kind of engineer's valve that can be, or is, used with this class of apparatus; wherefore, its introduction into the question renders the interrogatory irrelevant and immaterial and the answer incompetent.

A. In my opinion, the Westinghouse engineers' valve would not make suitable provision for the careful manipulation of the valve 22 so that it might act as a main valve, according to the theory of defendants' witnesses, when in a train made up of cars equipped with defendants', and with new Westinghouse, quick-action triple valves.

The facts that defendants' valves are to be interchangeable with the new Westinghouse quick-action triple valves, and that the action of said defendants' and the new Westinghouse quick-action valves are the same, in graduating, full service application, quick action, and release of the brakes, and that the results pro-
271 duced are the same, would indicate that both kinds of valves must respond to the same reductions of train or main air

pipe pressure, as well as to the same increase in pressure. If this was not the case, of course the actions of the two valves would be different, and, consequently, the results produced would also be different. For instance, with a reduction in train-pipe pressure caused by the manipulation of the engineers' valve which would cause the triple-valve pistons of the new Westinghouse quick-action triple valves to move into position for a graduating application, the pistons of the said defendants' quick-action triple valves must also necessarily move into such position, and, in the new Westinghouse valve, such graduating position is also the position for a service stop, or the application of the brakes with the greatest available power of the auxiliary reservoir alone, consequently such position of the triple-valve piston, in defendants' valves, when making a service stop, or a stop with the full available power of the auxiliary reservoir, is the graduating position of the triple-valve piston in said defendants' quick-action triple valves.

In other words, the only difference, in the new Westinghouse quick-action triple valve, between a graduating application and a full-service stop, is the difference between the time that the handle of the engineers' valve is held in the graduating position, that is, whether the handle is changed almost instantly after it had been placed in the graduating position, so that there is only allowed the time necessary for admitting a small quantity of auxiliary reservoir air to the brake-cylinder, for making a graduating application, or whether the handle of the engineers' valve is left in such graduating position for a continuous escape of train-pipe pressure, and consequently a continuous admission of auxiliary reservoir pressure to the brake-cylinder, until an equalization of pressures in the brake-cylinder occurs, when the brakes are applied with the full available pressure of the auxiliary reservoir. If said defendants' valves are to be interchangeable, they must necessarily so
272 operate that the valve 22 remains seated and cannot by any possibility act as a "main valve" in a train made up of said defendants' and the new Westinghouse quick-action triple valves as before stated.

In fact, in such a case, the valve 22 will always and invariably act, if it acts at all, as a quick-action valve, or rather as an auxiliary valve in a quick-action triple valve.

In order that said defendants' quick-action triple valves shall have the interchangeability referred to in said defendants' 1891 catalogue, any reduction of pressure in the main air or train pipe which would open the valve 22 would necessarily be such as would, at the same time, open communication directly from the main air or train pipe to the brake-cylinders, in the new Westinghouse quick-action triple valves, and therefore communication would likewise be opened from the main air or train pipe directly to the brake-cylinders connected with said defendants' quick-action triple valves, and the valve 22 would then act not as a "main valve," but as a portion or part of the mechanism relating wholly to quick-action or emergency stops.

In this connection, I would state that I have made experiments

with a valve like that shown in plate XI of defendants' 1891 catalogue, when coupled up with one of the new Westinghouse quick-action triple valves, and always found that the action of the valve 22, of said defendants' quick-action valve, operated as a portion of the quick-action devices, and not as a "main valve," when so coupled up, that is, any reduction in train-pipe pressure which would operate the new Westinghouse quick-action triple valve, for graduating or full-service application of the brakes, would invariably leave the valve 22 seated, and likewise any reduction of pressure in the main air or train pipe which would unseat the valve 22, would also open communication directly between the main air or train pipe and the brake-cylinder connected with the new
273 Westinghouse quick-action triple valve, which facts confirm me in the opinion heretofore expressed in this answer.

In these tests, as in others referred to by me, pressure gauges were used on the auxiliary reservoirs and brake-cylinders, and also upon the brake or train pipe side of the triple-valve piston, by which it could be determined what the pressures were in the respective parts of the apparatus.

I am also of the opinion that any engineers' valve with which I am acquainted, and which can be used with the new Westinghouse quick-action triple valves, in a train made up of both defendants' and the new Westinghouse quick-action triple valves, cannot be used so as to unseat the valve 22 of said defendants' valves, without also opening direct communication between the main air or train pipe and the brake-cylinders connected with the new Westinghouse quick-action triple valves.

In this connection, I have witnessed tests made with an engineers' valve having different-sized openings, which tests were made with a view to make the valve 22, of a quick-action triple valve like that shown in plate XI of defendants' 1891 catalogue, operate as a "main valve," that is, so as to open it and have pressure pass from the auxiliary reservoir to the brake-cylinder, without, at the same time, having main air or train pipe pressure also pass to the brake-cylinder, but this in each case was not done, although every effort possible was made to accomplish it. In each case, the pressures in the auxiliary reservoir and brake-cylinder equalized, before the opening of the valve 22, or, if this had not occurred, main air or train pipe pressure passed into the brake-cylinder notwithstanding the efforts made to have the valve 22 unseat before the equalization of pressures in the auxiliary reservoir and brake-cylinder had taken place.

The above facts compel me to the opinion that if there is to be any interchangeability whatever, of the character set forth in said defendants' 1891 catalogue, of the said defendants' and the
274 new Westinghouse quick-action triple valves, that any engineers' valve which is capable of use with a new Westinghouse quick-action triple valve would invariably and always cause the valve 22, of said defendants' quick-action triple valves, to act as a portion of the quick-action devices of those valves, and that such engineers' valve cannot, by any careful manipulation, be made to

cause the valve 22 to operate as a main valve, upon the theory of defendants' witnesses.

These last-named tests were made with a single quick-action triple valve, like that shown in plate XI of defendants' 1881 catalogue, and having glass windows in it, so that the operation of the valve 22 could be observed, and pressure gauges were arranged in the auxiliary reservoir, brake-cylinder, and the brake or main air pipe side of the triple-valve piston, so that the momentary pressures could be observed in the different parts of the apparatus.

220 Q. Referring to the Boyden patent No. 481,134, a copy of which is in evidence, I find on page 5, lines 86 to 95, the following statement, to wit:

"It will be seen that my present invention for introducing train-pipe air into the brake-cylinder for emergency stops differs essentially from the device shown in the said patent No. 360,070, because I have provided a new principle of construction and a new mode of operation, by use of which the desired result aforesaid may be produced without the aid of the auxiliary valve heretofore required for the purpose."

State, with your reasons, whether or not you find the statement I have quoted to be a true and correct one?

Adjourned to Tuesday, November 28, 1893, at 10.30 a. m.

275 NEW YORK, *November* 28, 1893—10.30 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of HENRY F. NEWBURY resumed:

A. to Q. 220. In my opinion, the statement in the question, quoted from Boyden patent No. 481,134, is untrue and incorrect, and not in accordance with the facts.

I find, upon turning to the specification of the said Boyden patent, that it contains a description of the mode of operation of the mechanism set forth in that patent, which description shows that, instead of there being a *new mode of operation*, there is the same mode of operation as found in the mechanism of the patent in suit.

In fact, the description of the mode of operation of the quick-action triple valve of said Boyden patent, as therein contained, is as much a description of the mode of operation of the quick-action triple valve set forth in the patent in suit, as it is of the quick-action valve of the said Boyden patent, or, in other words, the description of the mode of operation of the said Boyden patent, as aptly applies to the mode of operation of the quick-action triple valve of the patent in suit, as it does to the quick-action valve of said Boyden patent.

Of course, the designating letters or characters used in one patent would have to be substituted for those used in the other patent, to designate corresponding parts therein, and there would have to be a slight change, in one or two places, owing to the fact that auxiliary reservoir pressure unites with the train or main air pipe pressure at a somewhat different point, in the quick-action triple

valve shown in the said Boyden patent, from the point at which the two pressures unite in the quick-action triple valve shown in the patent in suit, but these changes in no way alter the
276 sense of the description, as such description applies to one mechanism as well as it does to the other, when the above changes are made.

In order to illustrate this fact, I will quote such description from the said Boyden patent No. 481,134, from the point where the reduction in train-pipe pressure has been made, which has brought the parts of the mechanism into position for a quick-action or emergency application of the brakes to take place.

I will also, in addition to making such quotation, place within brackets all designating terms or changes in language, as above indicated, in order to make the description apply to one quick-action triple valve or to the other, and, immediately after the matter placed in brackets, I will place the characters or language to be substituted, as above indicated, in italics, so that when the quotation is to be read, the matter within the brackets is to be read, omitting the matter in italics, and, on the other hand, when the description is to be read as applying to the Westinghouse quick-action triple valve, the matter within brackets is to be omitted, and that in italics is to be read in the place thereof.

This description will be found in lines 18 to 88, page 4, of the said Boyden patent.

"The piston [G] *12* will in the meantime be held to its outward position by the relatively higher air pressure from the auxiliary reservoir, which is delivered through the large [passage R] *valve chamber 24*, while the transmission of auxiliary reservoir air to the brake-cylinder is retarded by having to pass through the relatively smaller [passage *i*.] *port 35*. During its preliminary traverse outward, or toward the train-pipe side, the piston [G] *12* operates to close the exhaust passage, and its farther or continued movement in the same direction opens the [main valve F] *valve 41 and port 35*, and allows air to pass from both the auxiliary reservoir and the train-pipe to the brake-cylinder, when making a quick appli-
277 cation of the brakes. It will be observed that the valve mechanism depends for its action upon the movement of the piston [G] *12*, and that the latter is subjected to two opposing forces—auxiliary reservoir air on one side and train-pipe air on the other—and that its movement in one direction is effected by the preponderating pressure of auxiliary reservoir air, while its movement in the opposite direction results from a preponderance of pressure on the train-pipe side. If the [passage *i*.] *port 35*, through which auxiliary reservoir air must flow [upon the sudden opening of the main valve port *e*] for an emergency stop, was as large as or larger than the check-valve passage for supplying train-pipe air, the quick action referred to and the utilization of train-pipe air direct in the brake-cylinder could not be effected, for the very obvious reason that the inward flow of train-pipe air at, say, fifty-five or sixty pounds, to the brake-cylinder, would be opposed and checked by the flow of auxiliary reservoir air at a higher pressure,

say seventy pounds; but by restricting the *the* passage through which auxiliary reservoir air is conducted in the course of its transmission to the brake-cylinder, so that its capacity for the flow of air will be less than that of the [main port *e* and less than the] check-valve passage leading from the train-pipe, a considerable volume of train-pipe air will flow into the brake-cylinder, notwithstanding the admission of the auxiliary reservoir air under a high pressure, because the flow of auxiliary reservoir air is so retarded by the smaller [passage *i*.] *port 35*, through which it is conducted, that an appreciable period of time is required to raise the pressure in the brake-cylinder to that in the auxiliary reservoir, and it is during this interval, and before the pressure in the brake-cylinder is raised to that in the train-pipe, that the air in the latter is free to enter the brake-cylinder. It will thus be seen that the sudden

278 [uncovering of the main port or passage *e*, leading] *opening of the port 35 and passageway controlled by valve 41 which lead* to the brake-cylinder, by the movement of the [main valve] *piston 12* opens communication between the train-pipe and brake-cylinder, and also between the auxiliary reservoir and the brake-cylinder; but that the flow of the higher pressure air from the auxiliary reservoir into the brake-cylinder is retarded, by being compelled to traverse a relatively small orifice or passage, while the lower pressure train-pipe air is permitted to flow through a larger orifice or passage."

Reading the above quotation as it applies to the quick-action triple valve shown in the Boyden patent, and then by reading the same words, except omitting those within brackets, and including those in italics, as before suggested, will, I think, make it manifest that the description applies as aptly to one quick-action triple valve as it does to the other, and also, that the mode of operation is identically the same, and that there is no new principle of construction in said quick-action triple valve of said Boyden patent, but that the principle of construction is the same as that of the quick-action triple valve of that shown in the patent in suit, and that the difference between the two is only in specific details, which do not affect the mode of operation of the two valves.

A careful examination and comparison of the principle of construction and mode of operation of the quick-action triple valve shown in said Boyden patent, with that shown in the patent in suit, discloses the fact that the two quick-action triple valves are substantially identical in principle of construction and mode of operation, and also, that what slight differences in specific details of construction are found, are such as do not affect the principle of construction or the mode of operation of the two valves, and are wholly due to the fact that the higher auxiliary reservoir air

279 unites with the lower train or main air pipe pressure or air, to pass or expand into the brake-cylinder, at a somewhat different point, in the quick-action triple valve of said Boyden patent, than is the case with the quick-action triple valve shown in the patent in suit.

I have heretofore explained at length that this difference in the

point at which the higher auxiliary reservoir air unites and commin gles with the lower main air or train pipe air, to pass or expan into the brake-cylinder, in the two quick-action triple valves unde consideration, is wholly immaterial, and I will not repeat such rea sons at length, but simply say that such differences are immaterial because, in each case, they unite at a point which is practically i open communication with the brake-cylinder, and the two pressure can readily expand and enter the brake-cylinder, and this is as tru in one case as in the other.

Such examination and comparison of the quick-action triple valve of the two patents, one with the other, also discloses the fact, that i each there is a valve auxiliary to the valve which controls com munication between auxiliary reservoir and brake-cylinder, and th brake-cylinder and open air, for applying and releasing the brake respectively, and therefore, that the said quick-action triple valve o the Boyden patent is provided with an auxiliary valve, the same a is the case with the quick-action triple valve of the patent in suit Hence, the statement quoted in the question is incorrect and untru in this respect, as well as in the other respects heretofore pointed out in this answer.

Because of these facts, I am compelled to the opinion that the said quoted statement of the question is untrue and incorrect.

So far as the above answer purports to quote from the Boyden patent a description of the mode of operation of the structure described in that patent, the quotation is objected to by defend-
280 ants' counsel, for the following reasons, to wit:

(1) Because it is garbled and incomplete. The full description of the mode of operation commences at line 111, page 3, of the specification of the Boyden patent, with the wo ls, "When it becomes necessary or desirable to apply the brakes of a rain quickly and with full power for an emergency stop."

To omit the descriptive matter found between that point and the beginning of the quotation made in the witness' answer, is to omit the most vital part of the description. There are several other passages in the specification of the Boyden patent, descriptive of the mode of operation of the quick-action devices therein shown, which should also be included in the quotation to render it complete.

(2) Because, in making the quotation, the witness has substituted, in place of the matter contained in the Boyden patent, matter of description which does not relate to the devices of the Boyden mechanism, but to other and different devices, and has, without explanation, assumed such devices to be the same, or substantially the same, as those of the Boyden patent.

(3) Because the alleged quotation, garbled and altered by the introduction of other matter, evinces simply an effort to confuse and mislead the court as to the structures under consideration.

221 Q. Please examine the subject-matter contained in patent 481,134, from line 111, page 3, to line 18, of page 4, and state what, if anything, you find contained in such descriptive matter, or in any other portion of the specification of the patent, which in any-

wise tends to modify the views expressed in your last preceding answer?

A. I have examined the subject-matter contained in patent
281 481,134 from line 111, page 3, to line 18 of page 4, as called for in the question, although I had heretofore carefully examined such subject-matter, and there is nothing contained in such subject-matter, which in any way affects or changes the meaning of the language quoted by me from said Boyden patent 481,134, wherein the operation of the mechanism was set forth.

If the language contained between lines 111, page 3, and line 18, page 4, would in any way affect the operation of an apparatus or quick-action valve of that patent, I should have quoted it in the first instance, for the simple reason that I have no desire whatever to mislead or confuse the court.

The matter contained between lines 111, page 3, and 18, page 4, relates to the reduction of pressure in the main air or brake pipe, necessary for a quick-action application of the brakes to be made, and also explaining that when the triple-valve piston is brought to its extreme rearward position, by such reduction, the valve chamber is opened to the brake-cylinder, so that the higher auxiliary reservoir pressure, and lower brake or train pipe pressure, when they unite, can readily expand into the brake-cylinder, because the point of uniting of these pressures is in open communication with the brake-cylinder, which is also the case at the point where the corresponding pressures unite to enter the brake-cylinder in the quick-action triple valve of the patent in suit. These are necessary conditions in any and every quick-action triple valve, and arise wholly, in the quick-action triple valve of the Boyden patent 481,134, from the fact stated in my previous answer, namely, that the higher auxiliary reservoir and lower main air or train pipe pressure united in the quick-action triple valve of said Boyden patent at a somewhat different point from what the corresponding pressures unite to enter the brake-cylinder in the quick-action triple valve in the patent in suit.

The quotation of the matter between lines 111 of page 3
282 and 18 of page 4, would, if anything, tend to mislead or confuse the court, instead of bringing out into clear and distinct light the fact that the actual principle of construction or mode of operation of the quick-action triple valve of said Boyden patent was substantially identical with that of the quick-action triple valve of the patent in suit. I cannot see how the quotation of such matter would in any way tend to make clearer the facts of the case, and, if I had seen how the quotation of the matter between lines 111 of page 3 and 18 of page 4 would make clearer such facts, I should have unquestionably quoted it, for it is my earnest desire to present the facts just as they exist.

There is no question but what certain differences in construction exist between the quick-action triple valve shown in said Boyden patent and the one shown in the patent in suit, and such differences arise principally from the fact stated in my previous answer, that the auxiliary reservoir and main air or brake pipe pressures unite

to expand into the brake-cylinder, at a somewhat different point from that at which the corresponding pressures unite in the quick-action triple valve shown in the patent in suit, but this fact, as before stated, does not change the principle of construction upon which the two mechanisms work, or their mode of operation, so that the mode of operation of the quick-action triple valve of the said Boyden patent can be said to be a new mode of operation.

In my former answer, I stated the fact that there was a difference in the point at which the auxiliary reservoir and main air or train pipe pressure united to expand into the brake-cylinder in the quick-action triple valve of the said Boyden patent, and the point at which the corresponding pressures united in the quick-action triple valve of the patent in suit, so that it would be distinctly understood that this difference existed and was recognized in the answer and thus express the facts.

I do not find anything in any other portion of the said Boyden patent 481,134 which, taken in connection with the portion
283 of the specification of that patent which I quoted in my former
answer, would change the mode of operation set forth in that quotation, or in any way affect its meaning.

I am confirmed in the opinions expressed in this, and my preceding answer, namely, that the mode of operation or principle of construction of the quick-action triple valve shown in Boyden patent 481,134 is not a new mode of operation, or a new principle of construction, by the statement made by Mr. Boyden, in answer to X Q. 187, which, in substance, is, that there is no difference in the mode of operation between defendants' two valves shown in defendants' catalogues of 1889 and 1891, and in answer to X Q. 191, where he admits that it is a fact that the quick-action triple valve shown in plate IX defendants' 1889 catalogue, is patented in and by letters patent 481,134, and the statement contained in said defendants' 1891 catalogue, that the quick-action triple valve shown in plate XI of the last-named catalogue, is interchangeable with the new Westinghouse quick-action triple valve, as heretofore set forth.

If there is no difference in the mode of operation between the defendants' two valves shown in catalogues 1889 and 1891, and the valve shown in the 1889 catalogue is patented in and by Boyden patent 481,134, and the valve shown in defendants' 1891 catalogue is interchangeable with the new Westinghouse quick-action triple valve, it necessarily follows that there is no difference in the mode of operation between the quick-action triple valve shown in Boyden patent 481,134 and the new Westinghouse quick-action triple valve, and this is substantially admitted by Mr. Boyden, one of defendants' experts, and the person upon whose application the Boyden patent was granted.

Objected to by defendants' counsel, on the ground that the witness, in this answer, has given an incomplete and incorrect statement of the substance of the descriptive matter contained in the
284 Boyden patent between lines 111, page 3, and 18, page 4—
dwelling at length upon matters that are immaterial, and totally ignoring the essential and vital parts of the description.

Counsel for complainants suggests that the foregoing objection is not well founded, for that it merely recites the opinion of defendants' counsel, which may or may not be a correct one.

222 Q. To what extent, if at all, is your answer to Q. 220 applicable to the following statements of the Boyden patent No. 481,135, to wit:

"It will be seen that the means I have thus provided for introducing train-pipe air into the brake-cylinder for 'emergency stops' differs, essentially, from that shown in said patent No. 360,070, and that said means involves a new mode of operation" (lines 73 to 79 page 1).

"An examination of the particular embodiment of the present invention will disclose the fact that it is a triple valve *per se* without auxiliary or supplemental valve devices, and, further, that its conversion into a 'quick-action' valve and its greater capacity for action over previous forms of triple valves is due to means here employed for transmitting train-pipe air direct to the brake-cylinder through the triple-valve chamber C and through the port *c* of the triple main valve, and at the same time retarding or restricting the flow of auxiliary reservoir air to the said main ports as compared with the more open or free delivery of train-pipe air to said main port. It will also be seen that a single valve 22, the main valve of the triple valve proper, here performs the office of opening a port *c* to the brake-cylinder, through which port both the train-pipes and the auxiliary reservoir airs pass in the quick application of the brakes for emergency stops" (lines 80 to 181, p. 4).

285 A. My answer to Q. 220 is applicable to the statements quoted from Boyden patent 481,135, to the same extent as to the statement found quoted from patent 481,134 in question 220, so far as a new mode of operation of the mechanism shown in patent 481,135 is concerned, and also, to the statement regarding auxiliary or supplemental valve devices of the quotation in the present question.

Immediately following the last quotation in the present question, namely, at line 102, page 4, of Boyden patent 481,135, it is stated:

"In my application for letters patent filed September 30, 1889, serial No. 325,474, I have shown and described a valve for automatic air brakes of the same type as that which constitutes the subject-matter of the present specification. In my said earlier application the fundamental features of the invention have been claimed. The present specification therefore relates to certain improvements in the construction of said valves."

Turning to the beginning of the specification of patent 481,134, it will be seen that it was granted upon an application filed September 30, 1889, serial No. 325,474, the same as stated in the above quotation.

From this it appears that the quick-action triple valve shown in the two patents are of the same type, and therefore must have the same mode of operation and principle of construction.

Mr. Boyden, one of defendants' experts, in answer to X Q. 190,

struction simply renders the mechanism incapable of use, for any practical purpose in connection with an automatic air-brake system.

There are other reasons why the device set forth in patent
289 317,838 would render an automatic air-brake system useless, but it would seem that the above is a sufficient reason for the opinion expressed regarding this device and its practical use in an automatic air-brake system.

224 Q. Where, if at all, in patent 360,070, can you find any warrant for the interpolation, by defendants' witness J. B. Church, into his recital of the functions of the auxiliary-valve device of said patent, of the words "without passing through the triple valve proper" (D. R., fol. 743, page 186)?

A. I am unable to find any warrant whatever in the patent 360,070 for the limitation contained in the words quoted in the question upon the auxiliary-valve device of claim 1 of such patent. There is certainly nothing in the claim which calls for such limitation upon the auxiliary-valve device of that claim.

There is nothing that I can find in the drawings or the descriptive part of the specification which would seem to require any such limitation as Mr. Church has seen fit to adopt, and which is referred to in the question.

The quick-action triple valve shown in the drawings of the patent in suit No. 360,070 provides for the direct admission of brake or train pipe air into the brake-cylinder, by passing through a portion of the triple valve proper, as such triple valve proper is described in the patent in suit, that is, the main air or train pipe pressure which enters directly into the brake-cylinder without passing into the auxiliary reservoir, passes through a passageway, port, or conduit, through which auxiliary reservoir air or pressure always passes when the mechanism of the patent in suit is used as a triple valve proper, and therefore, such direct admission of main air or train pipe pressure is through a portion of the triple valve proper, or, generally stated, is through the triple valve proper, and not, as stated by Mr. Church, without passing through the triple valve proper. The portion of the triple valve proper through which the direct admission of air or fluid pressure is made from the
290 brake or train pipe, is as much a portion of the triple valve proper as any other portion of that mechanism which is used in making a graduating or full service application of the brakes, or, as stated by me in my former deposition herein, when performing the first two classes of work, namely, "graduation" and "service stops."

225 Q. Where, if at all, in patent 360,070, can you find any warrant for the limitation imposed by Mr. Church on the triple valve of said patent, that it shall "control the admission of auxiliary reservoir air to the brake-cylinder, *both* for graduating and full pressure applications of the brakes." (D. R., fol. 746, page 187.)

A. I am wholly unable to find any warrant whatever in patent 360,070, for the condition which Mr. Church has seen fit to impose upon the triple valve of the first claim of the patent in suit, if he meant, by the language quoted, that there was any difference be-

tween what he has styled "graduating and full pressure applications of the brakes," except that there is a difference in the time for the admission of auxiliary reservoir pressure to the brake-cylinder as heretofore explained by me.

226 Q. In the analysis of claim 1 of patent 360,070 made by Mr. Church on pages 185 and 186 (D. R.) he recites, among what he terms the "parts or elements" of said claim, the following, to wit:

"2. Means for maintaining and varying the air pressure in said main air or train pipe."

To what extent, if at all, do you consider the statement of such a part or element to be correct or justifiable in the analysis of said claim?

A. The "means for maintaining and varying the air pressure in said main air or train pipe," which Mr. Church has made his second part or element, in his analysis of said claim 1, I understand includes the engineers' valve, the main reservoir, and the air pump, with the engine which operates it, situated upon the locomotive.

291 As I understand said claim 1, it does not include such engine, air pump, main reservoir, engineers' valve and the necessary connections contained upon the locomotive, as any part or parcel of the combination particularly pointed out in claim 1 of the patent in suit.

As I understand said combination, it is complete when it contains the several parts or devices therein mentioned, when combined together in substantially the manner set forth in the descriptive part of the specification, and adapted for use in an automatic quick-action system of brakes, or, in other words, that the "brake mechanism" referred to in said claim 1, only refers to those portions of the mechanism necessary to make up the equipment of a single car.

Because of such understanding, I do not consider Mr. Church's statement of such a part or element of the combination recited in claim 1 to be correct or justifiable, in an analysis of the devices or elements of said claim.

227 Q. How far, if at all, do you consider Mr. Church's recital of what he terms the "fifth" element of claim 2 of patent 360,070 (D. R., pp. 187, 188) to be correct or well founded?

A. I do not consider Mr. Church's recital of what he terms the fifth element of the second claim of the patent in suit to be correct or well founded.

It would seem to me that Mr. Church must have had in mind the third claim of the patent in suit, instead of the second, when he made the recital of the said fifth element or part referred to in the question.

I do not find any warrant whatever, in claim 2 of the patent in suit for the limitation Mr. Church has seen fit to impose upon his said fifth part or element in his analysis of that claim, which limitation is in the following words:

"And effecting a second admission of auxiliary reservoir air to the brake-cylinder by the further movement or completion of the full stroke of the valve piston."

POOR COPY

292 I am unable to find anything in said claim 2 which would afford any warrant whatever for this limitation to be placed upon the triple valve referred to in said claim, and which Mr. Church has referred to in his said analysis as the fifth element.

It is true that such a second admission of auxiliary reservoir pressure to the brake-cylinder, as referred to by Mr. Church, is one of the limitations placed upon the combination recited in claim 3 of the patent in suit by the terms of such claim, but said claim 2 does not contain any such limitation.

There are other reasons why I do not think Mr. Church's recital of what he terms the fifth element of said combination of claim 2 of patent in suit, is correct and well founded.

If he had stated his said fifth element somewhat as follows, then I would have had to agree with him as to what such element is in said combinations:

5. A triple valve properly provided with two passages, one passage leading from the auxiliary reservoir to the brake-cylinder and the other passage leading direct from the main air or train pipe to the brake-cylinder, and also provided with a valve mechanism actuated by the piston of the triple valve which controls the two passages, the piston of the triple valve being adapted to have two traverses or movements, the first or preliminary one of which actuates the valve mechanism and opens the passage between the auxiliary reservoir and the brake-cylinder, and the second or further traverse or movement opens the direct passage between the main air or train pipe and the brake-cylinder.

The above statement of the fifth element of the combination recited in claim 2 of the patent in suit seems to me enumerates every condition that is called for by the terms of said claim 2, and is all that is required of the triple valve mentioned in said claim.

I understand that Mr. Church, when giving his fifth element of said claim 2, includes, as one of the preceding elements of
293 his analysis, the second element of said claim 1, and, as before explained in a previous answer, I do not understand that such element or part is any part of said claim 1, and consequently, would not be of said claim 2. Therefore, instead of making the triple valve proper, as before explained, the fifth element, I would make it the fourth, omitting Mr. Church's second.

Mr. Church, in giving his said analysis of the second claim of the patent in suit, says:

"I understand this claim to include the first four enumerated elements of the first claim, and, in addition thereto, a fifth element, as follows:"

228 Q. Do you or not find the following statement of Mr. Church (D. R. fol. 819, page 205) to be a true and correct one, to wit:

"the main valve H of the patent [No. 220,556] controlling the direct passage between valve chamber and brake-cylinder, and only operated to uncover the port leading to the brake-cylinder when the piston is actuated by the preponderance of auxiliary reservoir air pressure, and caused to make its full stroke, finds its functional

equivalent in the main valve 22 (or 15) of defendants' triple valves."

Adjourned to Wednesday, November 29, 1893, at 10.30 a. m.

NEW YORK, *November* 29, 1893.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of HENRY F. NEWBURY resumed:

A. to Q. 228. In my opinion, the statement referred to in the question is not a true and correct one. The language quoted in the question is found in the paragraph which commences as follows:

294 "Referring to said patent No. 220,556 of 1879 and comparing the same with defendants' triple valves, I find that they all possess substantially the same functions, are made up of equivalent parts that operate in substantially the same manner, omitting, of course, the quick-action function of defendants' valve and the means by which such action is produced."

From this it will be seen that the main valve H of patent 220,556, and the main valve 22 (or 15) of defendants' valves, are compared by Mr. Church in said paragraph, and are the valves which, in his opinion, are equivalent in function.

I wholly disagree with Mr. Church in any such opinion as this, and as a matter of fact, the main valve H, of patent 220,556, does not find its functional equivalent in the so-called main valve 22 (or 15), of defendants' triple valve.

Turning to said patent 220,556, it will be seen that the valve H of that patent has certain functions to perform, which are, controlling communication between the auxiliary reservoir and the brake-cylinder, to apply the brakes, and also, controlling communication between the brake-cylinder and the atmosphere, to release the brakes, or, in other words, the valve H has to be moved so as to close communication between the brake-cylinder and the atmosphere, as well as to open communication between the auxiliary reservoir and the brake-cylinder, in order that any kind of an application of the brakes can be made, and also, that the valve H has to be moved to close communication between the auxiliary reservoir and the brake-cylinder, and open communication with the brake-cylinder and the atmosphere, in order that any kind of a release of the brakes can be made, and that in either case this is true whether it be a partial or full application, or a partial or full release of the brakes.

295 Comparing the valve 22 (or 15), of defendants' quick-action triple valve, with the valve H of patent 220,556, it will be seen that even Mr. Church or Mr. Boyden, defendants' experts, do not even intimate that the valve 22 (or 15), of defendants' quick-action triple valve, has anything whatever to do, or that any movement whatever of such valve can take place upon a partial application or partial release of the brakes, with said defendants' quick-

action triple valve, or, in other words, they do not assert, or even intimate, that the valve 22 (or 15) of said defendants' quick-action triple valve, has any function or movement in the application or release of the brakes, in a graduating application of the same.

As I understand the testimony of both Mr. Church and Mr. Boyden, they attempt to assert that the valve 22 (or 15), of said defendants' quick-action triple valve, only opens or performs any valve function when the triple-valve piston is moved to the full extent of its stroke, and brings the parts of the mechanism into position for a quick action or emergency application of the brake, and the conditions, or momentary differential pressures, are such that they interfere with the direct admission of main air or train pipe pressure to the brake-cylinder, and thus two to five pounds of pressure are admitted to the brake-cylinder from the auxiliary reservoir, before the pressures in the reservoir and cylinder have equalized, and consequently, the valve 22 (or 15), of said defendants' quick-action triple valve, permits auxiliary reservoir air, to this small extent, to pass through the port opened by such valve 22 (or 15).

From this it will be seen that the valve H, of patent 220,556, does not, even according to the showing of defendants' experts, find its functional equivalent in the valve 22 (or 15) of defendants' quick-action triple valve.

As before stated, and for the reasons heretofore given at length, which I do not think need repeating here, the said valve 22 (or 15), of said defendants' quick-action triple valve, has to do wholly with the quick-action portion of said defendants' valve, and not
296 with the part or portion of those valves which serve the function of a triple valve proper.

Furthermore, all of the functions of a triple valve proper can be performed by said defendants' quick-action triple valves, without the presence of the valve 22 (or 15), and none of the functions of a quick-action or emergency application of the brakes can be served by the said defendants' quick-action triple valve, except that the valve 22 (or 15) be present, as is clearly shown from the tests witnessed by me and heretofore described.

These facts compel me to the opinion that the statement of Mr. Church referred to in the question is incorrect and untrue, and that the valve H of patent 220,556 does not find its functional equivalent in the valve 22 (or 15) of said defendants' quick-action triple valves.

229 Q. Do you, or not, find the following statement of Mr. Church, in folios 827, 828, p. 207 (D. R.) to be a true and correct one, to wit:

"A comparison of the mechanism of defendants' triple valve with the triple valve of patent 141,685 of August 12, 1873, will serve to illustrate the fact that the main valve 22 of the 1891 triple valve (which operates to perform the same functions of admitting auxiliary reservoir air to the brake-cylinder upon the full stroke of the piston, and is the equivalent of main valve 15 in the 1889 triple

valve) is the main valve, and corresponds in its functions with the main valve *a*, of the patent referred to"?

A. I do not find the said statement of Mr. Church's to be true and correct, because a comparison of the mechanism of defendants' quick-action triple valve with the triple valve of patent 141,685 of August 12, 1873, shows that the valve *a* of such patent is necessarily moved in both directions in making a partial application of the brakes, as well as when a partial release of the brakes is to be
297 made, and this is not the case with said defendants' quick-action triple valve, even according to Mr. Church's own description. This fact illustrates the incorrectness of Mr. Church's said statement, and shows the fact to be that the valve 22 of the 1891 triple valve, and the valve 15 of the 1889 triple valve, is not the main valve of those mechanisms, and that they do not correspond in function with the valve *a* of patent 141,685.

The valve *a*, of patent No. 141,685, which Mr. Church has termed "main valve *a*" of that patent, is not so termed in the patent itself, but is there called a "charging valve *a*," and as there shown and described, simply controls communication between the auxiliary reservoir and brake-cylinder, and is not, in my opinion, correctly termed by Mr. Church, and it will be just as correct to term the valve h^1 a main valve, which latter valve controls the release or exhaust of fluid pressure from the brake-cylinder, by controlling communication with such cylinder and the atmosphere. This latter valve, the said patent terms a "discharging valve h^1."

In order to have a valve correctly termed the "main valve" of a triple valve proper, or, as more generally termed, a plain triple valve, it must, in my opinion, be capable of performing the main function in a triple valve proper, or plain triple valve, such, for instance, as controlling the lines of communication between the auxiliary reservoir and the brake cylinder, and between such cylinder and the atmosphere, or at least must serve some function, and be moved in order to serve such function, in connection with both of these lines of communication, when the mechanism serves the functions of a triple valve proper. This is the case with the main valve H of patent 220,556, and is not the case with the charging valve *a* of patent No. 141,685, and, in order to get anything which corresponds in function to a main valve, as I understand the same, in this latter patent, it would require to have both the charg-
298 ing valve *a* and discharging valve h^1, to make up such valve, and one would no more be the *main valve* of that mechanism than the other.

Because of these facts, I am compelled to the opinion that the statement of Mr. Church's referred to in the present question, is incorrect, untrue, and misleading.

230 Q. In his discussion of the operation of defendants' quick-action triple valve, plate IX defendants' 1889 catalogue, Mr. Church says, on page 196 (D. R.)

"The conversion of this triple valve proper, possessing the ordinary triple-valve functions, into a *quick-action* triple valve is most

ingeniously effected by the proper proportioning of the air ports or passages."

And he goes on to say, in that connection, how "it becomes possible to produce or occasion *differential pressures* in the piston chamber and the valve chamber," &c.

It is my impression that you have given, in your previous testimony, a statement of your view to an entirely different effect from that as above expressed by Mr. Church, and I wish you would state briefly whether I am correct in this, and, if it is necessary to make yourself clear, refer to any previous portions of your deposition by reference to which a reply to this question may be stated as briefly as possible?

A. My views do not coincide with those expressed by Mr. Church in the statements referred to in the question, as will appear, I think, in those portions of my deposition regarding the materiality of the partition 9, the point where the auxiliary reservoir and main air or train pipe pressures unite to enter or expand into the brake-cylinder, and what I have said regarding "differential pressures" and "momentary differential pressures," and where an apparatus was first found in which there was a quick-action triple valve which necessarily worked upon the principle of such momentary differential pressures.

231 Q. Do you, or not, find the statement of Mr. Church, in folios 850, 851, page 213 (D. R.), that "the results effected by the
299 additional members of the patented device (patent 360,070) are produced in defendants' valves directly by the triple valve proper and without the addition of an extra passage or an auxiliary valve" to be a true and correct statement?

A. In my opinion, the statement of Mr. Church, referred to in the question, is not a true and correct presentation of the fact.

I have heretofore, at considerable length, given my reasons why there is an auxiliary valve in the said defendants' triple valve, and that the said auxiliary valve is necessarily an addition to said defendants' valves, when such valves are used simply as triple valves proper, or, in other words, the said defendants' valves are provided with an additional valve, which is auxiliary to the valves which perform the ordinary function of a triple valve proper, and without which it would be impossible for said quick-action triple valves to make a quick-action or emergency application of the brakes.

It is true that in said defendants' valves the passage, port, or conduit, through which the direct admission of main air or train pipe pressure to the brake-cylinder takes place, is also utilized for the passage of main air or train pipe pressure to the auxiliary reservoir, but such passage, conduit, or port, is given an *extra capacity* over what is required as a feeding-in port or passage for admitting main air or train pipe pressure to the auxiliary reservoir.

Furthermore, if defendants' quick-action triple valves were not provided with a passage, conduit, or port, having this extra capacity, they would be incapable of making a quick-action or emergency application of the brakes, and therefore, this extra capacity of the passage, conduit, or port, of said defendants' quick-action triple

valve, is additional to any of the functions of a triple valve proper, and is also useless for anything else than a quick-action or emergency application of the brakes, and belongs wholly to the quick-action or emergency part or portion of said defendants' quick-action triple valve, and is as much additional to what is necessary
300 for a triple valve proper, in the case of said defendants' valves, as that part of the passage, conduit, or port, of the patent in suit, which is used alone for the direct admission of main air or train pipe pressure to the brake-cylinder.

In this connection, I would say that I have witnessed various tests with quick-action triple valves like the one illustrated in plate XI of defendants' 1891 catalogue, wherein the check-valve, which is designated in said plate XI as 26, was so limited in its movement that it could only open sufficiently to form a feeding-in port or valve, for controlling the admission of main air or train pipe pressure to the auxiliary reservoir, and, in every case, it was simply an impossibility for a quick-action or emergency application of the brakes to be made, and this was also the case, even when such check-valve 26 could open more than was necessary or desirable to form a feeding-in port or passage for admitting main air or brake pipe pressure to the auxiliary reservoir.

These tests leave no doubt in my mind, and also, I think, make it apparent, that the said defendants' quick-action triple valves have an extra passage, port, or conduit, in function as much so as in the case in the quick-action triple valve shown in the patent in suit.

These tests also show that the statements of Mr. Church immediately following the one quoted in the question, are, to say the least, misleading. These statements are as follows:

"And that the only substantial change which is required to convert a triple valve proper into what is known as a 'quick-action triple valve' is the separation of the valve chamber from the auxiliary reservoir end of the piston chamber, and the introduction of the small passage *e* (or B) through which auxiliary reservoir air is compelled to pass in entering the valve chamber. *With these changes* and the use of a check-valve for the feeding-in valve (a use
301 which was common in the art as exhibited in numerous prior patents, as, for example, patents Nos. 144,006, of October 28, 1873; 166,386 of August 3, 1875, and 280,285 of June 26, 1883,) *Mr. Boyden has succeeded in making a triple valve perform the operation of admitting train pipe air directly into the brake-cylinder* without interfering with its functions as a triple valve proper, and without the addition of anything corresponding in name, construction or mode of operation with the auxiliary valve and its passage connecting the train-pipe and brake-cylinder, which auxiliary valve and passage constitute two of the three additional members of the patent 360,070, and are absolutely essential to the operation of the device described in the patent, when used to effect a discharge of train-pipe air directly into the brake-cylinder."

With the changes suggested by Mr. Church, namely, the separation of the valve chamber from the auxiliary reservoir end of the piston chamber, by the introduction of the small passage *e* (or B),

and the addition of a check-valve for a feeding-in valve, the same as shown in patent 280,285, there would not be produced a structure which would necessarily *sarily* perform the operation of admitting main air or train pipe pressure directly into the brake-cylinder, and there would have been left something else to be done in order that such a result could be accomplished.

This something else would be the giving of the check-valve passage, port, or conduit, a capacity which it is not shown to have in said patent 280,285, and this has been done in said defendants' quick-action valve.

Because of the above facts, I am compelled to the opinion that said defendants' quick-action triple valves have an auxiliary valve and an extra passage, conduit, or port, in function at least, and that said valves are only able to accomplish the result that they do accomplish, by reason of additional members being added to a
302 triple valve proper, and that such additional members are, in substance, the same as those found in the patented device of the patent in suit, and that they perform the same functions in substantially the same way; and, it is admitted by Mr. Boyden, one of defendants' experts, that according to defendants' 1891 catalogue, the actions of said defendants' valves, and the results produced by such actions, are the same, and so long as this is true, and I believe it is unquestioned, the said defendants' valves must necessarily be provided with additional members, which are, so far as actions and results go, substantially the same as those of the patent in suit.

232 Q. In his answer to Q. 12, Mr. Church alleges that there is a difference in "principle or mode of operation" between the patented device of patent 260,070 and the defendants' device. Do you or not, find the supposed difference alleged by Mr. Church in his answer to exist?

A. As a matter of fact, there is no difference in principle or mode of operation between the said defendants' device, which I understand to be defendants' quick-action triple valve, and the quick-action triple valve shown in the patent in suit No. 360,070, and I have heretofore in my deposition given the reasons for so stating, and will not, at this time, repeat them. I have also described tests which show that the fact is as above stated.

The reasons above referred to will be found in those portions of my deposition which refer to the principle of construction and mode of operation of said defendants' quick-action triple valve and the quick-action triple valve shown in the patent in suit.

233 Q. In his answers to questions 14 and 15, Mr. Church comments upon and criticises your testimony as to the quick-action triple valve of patent 360,070, the defendants' quick-action triple valves, and the classes of work performed. Please indicate the error or fallacy, if any, that you may find in Mr. Church's statement of his views?

303 A. Mr. Church at the beginning of his answer to Q. 14, states that I have sought to convey the impression that the quick-action triple valve of patent 360,070 is adapted to perform three classes of work, namely, "graduating," "service stop," and

"emergency stop," and that the ordinary triple valve, whether of the form shown in patent 220,556 or other known form, is capable of performing but two of the three enumerated classes of work, to wit, "graduating" and "service stops," and then says, in his opinion, I am in error and the facts do not justify my conclusions.

In my former deposition I defined the three classes of work, which I so termed (folios 102 to 106, C. R.). Mr. Church utterly fails to point out anywhere in the prior art, including patent 220,556, where any mechanism is found by which the three classes of work as defined by me can be performed, and does not even assert, as I understand his testimony, that there existed in the art prior to the date of the invention of the patent in suit, a mechanism by which such three classes of work could be performed.

Mr. Church totally ignores my definition, and simply attempts to show that, so far as a single triple valve proper is concerned, that the Westinghouse patent 220,556 shows a mechanism by means of which the brakes controlled by such a single valve can be applied quicker than when a graduating application of the brakes, as he terms my first class of work, is made, and that this would necessarily be done by the engineer when he desired to apply his brakes in the case of an accident, or when the train broke in two, or the train-pipe burst and allowed of the entire escape of the main air or train pipe pressure therefrom.

It would seem that these comments of Mr. Church upon the three classes of work as termed by me, and upon patent 220,556 in connection therewith, were simply a play upon words, for he does not even make the attempt to show that patent 220,556 can perform the third class of work as defined by me in my previous deposi-
304 tion; therefore, I think the simple fact that he does so fail, is a sufficient answer to what he has said in connection with this matter, and makes it perfectly plain that there was no error whatever upon my part, and that the facts do justify my conclusion, but are fatal to his opinion.

I will here state that the first class of work which I, in my former deposition, termed "graduating" is what I understand defendants' experts, including Mr. Church, refer to as "a graduating application of the brakes."

The second class of work, which I termed as "service stop," said defendants' experts term "a service-stop application of the brakes."

The third class of work, which I termed as "emergency stops," said defendants' experts have termed as "a quick-action application of the brakes or, "a quick-action or emergency application of the brakes."

In each case, the class of work which I designated as third and termed "emergency stops" and the same class of work which defendants' experts have termed "a quick-action application of the brakes," or "a quick-action or emergency application of the brakes" is the same, and each requires that there shall be a direct admission of main air or brake pipe pressure to the brake cylinder, in addition to the pressure entering the brake-cylinder from the auxiliary reservoir, and it seems to me wholly

immaterial, and not of the slightest consequence whatever, whether these three classes of work are termed as I term them in my former deposition, or are termed as defendants' experts have so termed them in their depositions, which latter terminology I have largely used in the present deposition.

The essential thing is, so far as concerns the third class of work, that a direct admission of main air or train pipe pressure to the brake-cylinder takes place as set forth by me in my former deposition.

At folio 102, (C. R.) I give the reason why triple valves have become known as quick-action triple valves, and then state that such quick-action triple valves, in automatic systems of brakes,
305 perform three classes of work, enumerating such classes as above stated, and also defining the occasions when such three classes of work would be performed, and stated that the two first classes were performed, more or less perfectly, by all known constructions of triple valves, as they existed prior to Mr. Westinghouse's invention. Then I went on to state as follows:

"The present invention or the invention of the patent in suit has to do with the combining of certain devices with the old automatic system by means of which the additional or 'further function' requisite for 'quicker and more efficient action of the brakes is obtained,' which function covers the third class of work above referred to, viz., 'emergency stops,' and these three classes of work are performed when occasion requires by the use of substantially the same means, each class of work being performed as desired by simply varying the manner of using such means."

Mr. Church, in his answer to said Q. 14, when referring to my classification of said three classes of work, says regarding me, as follows:

"He has entirely ignored the action of the ordinary triple valve *when used in an emergency* or when 'automatically' operated to apply the brakes with maximum power in the shortest possible time."

As a matter of fact, I did not ignore the use of an ordinary triple valve as he states. There is no pretense, as I understand Mr. Church, upon his part, or of any one else connected with this case, that there is any such operation possible with the ordinary triple valve as to cause one triple valve to quicken the action of the next succeeding triple valve, and thus cause the application of the brakes in a shorter or quicker time, as set forth by me in my former deposition, and, so long as this is the case, there was no occasion whatever for me to refer to the automatic application of the brakes in systems
306 where triple valves proper alone were used, and Mr. Church's reference to it would seem to be only for the purpose of misleading the court, as it had nothing whatever to do with my classification of work in my former deposition.

Mr. Church, in his said answer to Q. 14, says as follows:

"In referring to the defendants' quick-action triple valve, Mr. Newbury has again ignored the third class of work, to wit: 'emergency stops,' as properly belonging to the triple valve proper. Defining the triple valve proper as one capable of performing the two classes

of work which he calls 'graduating' and 'service stops' (which classes of work I have termed 'graduating,' inasmuch as they are performed through the medium of the graduating valve, or the main valve when operated to partly or temporarily uncover its port), he has selected the graduating valve 40 of defendants' 1891 catalogue, and the graduating valve 13 of defendants' 1889 catalogue, and, properly attributing those two classes of work to the performance of said graduating valve, he has undertaken to say that said graduating valves are the main valves, and that the valve 22 is a valve auxiliary to *his so-called main valve*, whose function it is to open communication between the train-pipe and the brake-cylinder."

Mr. Church then states that he most emphatically disagrees with me on this point, and goes on to state his reasons.

It is true that what Mr. Church has seen fit to assume was meant by "emergency stops," when that term was used by me in my former deposition, was ignored by me when considering defendants' quick-action triple valve, and very properly done so by me for the simple reason that Mr. Church's assumed "emergency stops" are something entirely different from what I explained my third class of work and designated emergency stops to be. Mr. Church
307 does not make the slightest attempt to show that a "quick-action or emergency application of the brakes," as he has seen fit to term my third class of work, is performed by the ordinary triple valve or "triple valve proper" as it existed prior to 1887, and, therefore, according to his own showing, such third class of work should be ignored as properly belonging to the triple valve proper or plain triple valve, as the same is more generally known.

Referring to the last quoted statement of Mr. Church, I would say that I am unable to find in defendants' 1891 catalogue, any valve designated by the numeral 40, or any designation whatever in connection with the quick-action triple valve shown in plate XI of that catalogue, which is as high in number as 40.

Adjourned to Thursday, November 30, 1893, at 9.30 a. m.

NOVEMBER 30, 1893—9.30 a. m.

Met pursuant to adjournment.

Present: Counsel as before.

Deposition of HENRY F. NEWBURY resumed:

(A. to Q. 233 continued:) The only valve which can be used in a graduating application of the brakes, in defendants' quick-action triple valve shown in plate XI of defendants' 1891 catalogue, is the ports and passage in what I have termed the main valve of that mechanism, and which I marked with the designating characters *i*, *k*, and *j* in my former deposition. These ports *i*, *j* and *k* are in that portion of said main valve designated as 18, and they operate in conjunction with that portion of the main valve which controls communication between the brake-cylinder and the atmos-
308 phere, and therein designated as 17. The valve 22 of said defendants' quick-action triple valve simply acts as a parti-

tion and not as a valve, when such quick-action triple valve is used as a triple valve proper.

I understand that the valve to which Mr. Church applies the designating numeral 40, is the same as the part of the main valve to which I have applied the designating characters *i, j, k*, which valve is used not only when "graduating" or making a "graduating application of the brakes" but also when making "service stops" or "service-stop applications of the brakes."

It will be observed that in the above quotation, Mr. Church says that I "properly attributed those two classes of work to the performance of said graduating valves," from which I understand that Mr. Church admits that the two classes of work which I termed "graduating" and "service stops" are properly attributed to the said graduating valves, and even according to Mr. Church's own description of defendants' quick-action triple valve, there would be required, in connection with his so-called graduating valve, the use of what he has termed the release valve, in order that either a graduating or service-stop application of the brakes be made.

If such two classes of work are properly attributed to said so-called graduating valve and release valve, as Mr. Church in substance states, then Mr. Church must agree fully with me that the functions of a "triple valve proper" are performed by such two valves, and therefore, such valves are the main valves of defendants' quick-action triple valves illustrated in plate XI of defendants' 1891 catalogue.

Mr. Church also says in said quoted statement, that I have undertaken to say that said graduating valves are the main valves, and that the valve 22 is a valve auxiliary to my so-called main valve, whose function it is to open communication between the train-pipe and the brake-cylinder.

It is true that I not only undertook to say, but that I did
309 say, and do now say, that said graduating valves, (which of
course includes Mr. Church's so-called release valves) are the main valves of said defendants' quick-action triple valves, and such valves perform the functions of a triple valve proper, as I have heretofore shown, and because such is the fact they are necessarily the main valves of said defendants' quick-action triple valves.

It is also true that I did say in my former deposition, and now say, as I have heretofore repeatedly done, that the valve 22 of said defendants' quick-action triple valves is a valve auxiliary to the main valves of those mechanisms, whose function is to open communication between the main air or brake pipe and the brake-cylinder. The reasons why I have heretofore said that the valve 22 of said defendants' quick-action triple valves, is a valve auxiliary to the main valves of those mechanisms, I have heretofore given at length, and, therefore, will not again repeat them, but will simply say that if I have properly attributed the two first classes of work heretofore designated by me to the said graduating valves, including of course the so-called release valve, as Mr. Church states, then it necessarily follows that the valve 22 of said defendants' mechanism is a valve auxiliary to the main valves thereof.

If I properly attributed my two first classes of work to the said graduating valves, of course including the so-called release valves, as Mr. Church states, then every reason which Mr. Church gives for his opinion is necessarily of no weight or importance, and would simply go to show that such reasons were immaterial and of no weight in comparison with the statement above made by Mr. Church; for, if I properly attributed my first two classes of work to the said graduating and release valves, the facts that Mr. Church refers to as the reasons for his opinion have no real bearing upon the matter, and I will not further refer to such reasons of Mr. Church.

Mr. Church is asked, in Q. 15, as follows:

310 "Is a braking force, which is just sufficient to stop a train of cars running at a given speed on a level track, sufficient to stop the same train, running at the same speed, on a downgrade?"

To this question Mr. Church answers

"No; and this illustrates the absurdity of Mr. Newbury's classification of work performed by the ordinary triple valve," &c.

I am entirely at a loss to see anything in connection with this question which would illustrate anything absurd about my classification of work as heretofore made.

It would as well illustrate the absurdity of calling a graduating application of the brakes such, because, as a matter of fact, the braking force which would be a graduating application of the brakes, according to Mr. Church, when upon a downgrade, would necessarily be a service-stop application of the brakes when used upon an upgrade, but I must admit that I cannot see the slightest absurdity in these facts.

Every person having the slightest knowledge of the application of brakes to the wheels of cars, fully understands that, under varying circumstances, varying degrees of force must be employed, in order that the same result shall be obtained, and this is all there is that I can see in said Q. 15 and the answer thereto, and there is, as before stated, nothing which in any way would tend to illustrate any absurdity whatever in the classification of work as made by me, any more than it would be absurd as to the classification of the work made by defendants' experts, including Mr. Church.

234 Q. The specification of complainants' patent 360,070 contains the following disclaimer, to wit:

"I am aware that a construction in which 'an always-open one-way passage' from the main air pipe to the brake-cylinder is uncovered by the piston of the triple valve simultaneously with
311 the opening of the passage from the auxiliary reservoir to the brake-cylinder, has been heretofore proposed, and such construction, which involves an operation different from that of my invention, I therefore hereby disclaim."

State whether or not you find either of defendants' quick-action triple valves (plate IX defendants' 1889 catalogue of plate XI defendants' 1891 catalogue) to be within the terms of said disclaimer, and state also, by reference to the certified copy of file-wrapper and contents of patent 360,070, the circumstances under which said disclaimer came to be made?

The last clause of the question commencing with the words "and state also" is objected to, on the ground that the record itself shows the circumstances under which the disclaimer was entered, and is therefore the only competent evidence thereof, and it is presumable that the witness knows nothing about said circumstances, except what he has learned from said record, and is therefore incompetent to testify on the point.

A. I do not find either of said defendants' quick-action triple valves (plate IX defendants' 1889 catalogue or plate XI defendants' 1891 catalogue) to be within the terms of said disclaimer, because the construction referred to in said disclaimer is one in which the "always-open one-way passage" is to be at all times open to the same extent, and is not to be any more obstructed at one time than it is at another; therefore, said defendants' quick-action triple valves, which have a passage that is not always open to the same extent when the port leading to the brake-cylinder is open, but which have such passage obstructed and not open for the greater portion of the time, do not have an "always-open" passage, and are not within the terms of said disclaimer. In defendants' quick-action triple valve illustrated in plate IX of said 1889 cata-
312 logue, the port leading to the brake-cylinder is opened by
the portion of the main valve therein designated as 13, but by me also designated as 18, at which time there is not an always-open passage from the main air or train pipe to the brake-cylinder, because such passage is closed during the time that the port leading to the brake-cylinder is opened by this valve.

In defendants' quick-action triple valves illustrated in plate XI of defendants' 1891 catalogue, the port leading to the brake-cylinder is open, whenever the triple-valve piston and its connected stem is moved backward enough to bring the port *i* in open communication with the chamber C, and at this time, in said defendants' quick-action triple valves, there is not an open passage between the main air or brake pipe to the brake-cylinder, for the reason that this passage is closed during the time that the port leading to the brake-cylinder is so opened by this port *i*.

Because of these facts, the said defendants' quick-action triple valves do not contain an always-open one-way passage leading from the main air or brake pipe to the brake-cylinder.

Referring to the file-wrapper and contents of the patent in suit, I find that the same communication which inserted the above-named disclaimer in the patent in suit, also cancels certain matter in the specification of the application as it then stood. This matter so canceled reads as follows:

"Further, while in the specific construction described and shown, the function of admitting air from the main pipe is performed by a valve separate from that which effects the preliminary admission of reservoir pressure to the cylinder, a modification in which the same office is performed by a valve integral with the main valve and formed by an extension thereof, would be included in and embody the essential operative features of my invention."

313 I would here state that, near the beginning of my investigation in connection with the quick-action system of brakes, I had occasion to investigate the file-wrapper and contents of the patent in suit No. 360,070 in the Patent Office in Washington, and at that time, became aware of not only the circumstances under which the said disclaimer was inserted, but also that the above-quoted statement was stricken or erased from the application for the patent in suit.

When I was called upon to testify in this case, something over two years since, I gave such matter careful consideration in connection with said defendants' quick-action triple valves, and, while, in each of said quick-action triple valves, the function of admitting air from the main air or train pipe is performed by a valve separate from that which effects the preliminary admission or reservoir pressure to the brake-cylinder, nevertheless I had the matter so stricken or erased from the specification wholly in mind, when I gave my former testimony in this case, as well as while giving my present deposition, and have, at all times, been of the understanding that a quick-action triple valve, in which the function of admitting main air or train pipe pressure directly from the main air or train pipe to the brake-cylinder, was performed by a valve which was integral with the main valve, and formed by an extension thereof, would be included within the invention of the patent in suit, because it would embody the essential operative features of such invention.

Or, in other words, the essential operative features of the invention would be the same when a valve composed of a single piece of material, controlled a port or ports leading from both the auxiliary reservoir to the brake-cylinder, and directly from the main air or train pipe to the brake-cylinder, and was adapted to so control such ports that the three classes of work heretofore referred to by me would be performed in the manner set forth, as would be the case when such ports or passages are controlled by valves com-
314 posed of two separate pieces of material, which two valves controlled such two ports in a similar manner for performing the same three classes of work.

235 Q. In view of the official letters in the application for patent 360,070, as shown by the copy of file-wrapper and contents in evidence, to what, if any, prior patent do you understand the disclaimer quoted in Q. 234 to more particularly relate?

Objected to as immaterial.

A. I understand that the disclaimer was called for by patent No. 280,285, granted to G. A. Boyden, June 26, 1883, and therefore that said disclaimer relates more particularly to the said Boyden 1883 patent than to others which may be within the terms of said disclaimer.

236 Q. To what extent, if at all, do you find the modification referred to in the matter canceled from the specification filed in the application for patent 360,070, as quoted by you in your answer to

Q. 234, to be shown, described, or suggested in said Boyden patent No. 280,285?

A. There is nothing whatever, in the said Boyden patent No. 280,285, which in any way suggests or hints at a construction which would be the modification or equivalent thereof, referred to in the matter canceled from the application for patent 360,070, as quoted by me in answer to Q. 234.

Cross-examination by LYSANDER HILL, Esq., of counsel for defendants:

236 X Q. Referring to the defendants' quick-action air-brake apparatus, as illustrated in plate XI of defendants' 1891 catalogue and plate IX of defendants' 1889 catalogue, what do you understand to be the functions of the partition 9 of that apparatus?

A. I understand the functions of the so-called partition 9, of said defendants' quick-action triple valves, to be that of furnishing a means of protecting the triple-valve piston from a too sudden
315 reduction of auxiliary reservoir pressure by the expanding of the same too quickly or suddenly into the brake-cylinder, and, by so doing, to cause the triple-valve piston to close communication between the auxiliary reservoir and the brake-cylinder, and to also open communication between the brake-cylinder and the atmosphere before the desired application of the brakes is made.

In addition to the above, the particular part or piece of material which is designated as 9, and here referred to as the partition, also serves the function of supporting and guiding the triple-valve piston in its movement back and forth, by the contact of such part with the triple-valve piston.

This particular part or piece of material, designated as 9, forms only a portion of the partition between the triple-valve piston and the brake-cylinder, as said defendants' quick-action triple valves are illustrated in said plates of defendants' catalogues.

The actual partition in said defendants' quick-action triple valves, as the same are illustrated in said plates of defendants' catalogues, contains a restricted port or passage which restricts or retards the expansion of auxiliary reservoir pressure while such pressure enters the brake-cylinder; therefore the partition itself, between the auxiliary reservoir side of the triple-valve piston and the brake-cylinder itself, must serve the function of restricting or retarding the passage of auxiliary reservoir pressure while the same is passing to the brake-cylinder, by reason of providing such restricted port or passage which performs this retarding or restricting work.

237 X Q. Have you, in your last above answer, fully described and explained all the functions of said partition 9 in said defendants' apparatus?

A. I have described all that I call to mind at this moment; of course understanding the partition 9 to be something more than simply the piece of material designated as 9 in said defend-
316 ants' 1891 catalogue, and the corresponding piece of material designated by me as 9 in said defendants' 1889 catalogue.

238 X Q. What do you mean when you say, "of course understanding the partition 9 to be something more than the simple piece of material designated as 9, in said defendants' 1891 catalogue, and the corresponding piece of material designated by me as 9 in said defendants' 1889 catalogue"?

A. I mean, of course, the partition between the auxiliary reservoir side of the triple-valve piston and the brake-cylinder, the piece 9 being only a small part of such partition.

The merest glance at said defendants' 1891 and 1889 catalogues discloses the fact that the piece 9 forms only a small part of such partition, and furthermore, the restricted port or passage through such partition is not through the piece 9, but is elsewhere located, and this restricted port or passage could be differently located from what is there shown, and yet have such partition and restricted port or passage perform every function they now perform, and perform such functions in precisely the same manner as now.

Boyden patent 481,135, when referring to the part designated as 9 in defendants' quick-action triple valve, as the same is illustrated in the drawings of said patent and plate XI of defendants' 1891 catalogue, calls it "a brass bushing 9, which serves in part as a partition and separates the piston chamber D from the valve chamber C."

The specification of the said Boyden patent then goes on to say: "A small passage B opens in the present instance between the piston chamber B and the valve chamber C, and forms a communication through which air from the auxiliary reservoir is admitted to the valve chamber C, and *vice versa*."

From this it will be seen that the part designated as 9 does not, of itself alone, form the partition which contains the restricted port or passage, and that such partition is composed of something
317 more than such part 9, and this is what I meant in my previous answer.

239 X Q. You say that the partition is composed of something more than the part 9; state all that it includes, according to your understanding?

A. The "partition" includes everything which forms a wall between the auxiliary reservoir side of the triple-valve piston and the auxiliary reservoir on one side, and the valve chamber and brake-cylinder upon the other, and any part of which when removed would open communication between the auxiliary reservoir, or auxiliary reservoir side of the triple-valve piston, and the valve chamber or brake-cylinder, or, in other words, all those portions of material in said defendants' quick-action triple valve which compel auxiliary reservoir pressure to pass through the restricted port or passage provided in this partition.

240 X Q. Please name, specifically, each and every part that enters into and forms a portion of the device that you call the "partition" in question?

A. I cannot do so any more specifically than I have already done, and I think it is perfectly plain what the wall is to which I have referred in the said defendants' catalogues, and in order to specify

these parts, I should have to so cover up the said plates in said catalogues as to render the designating characters and marks already upon them either unintelligible or so confused as to interfere with their being understood.

In order to make my meaning more clearly understood, I would say that all portions of the walls of the passage A, in plate XI of defendants' 1891 catalogue, which are between such passage A and the valve chamber or brake-cylinder passage, are necessarily included within said partition, and if an opening were made between such passage A and the valve chamber C, of the size of the passage A, in addition to the restricted port or passage, it would simply destroy the effectiveness of such partition and render the mechanism useless as a quick-action triple valve, although, as I under-
318 stand the matter, the mechanism would be capable of performing every function of a triple valve proper.

From what I have said, I think it will be apparent that the metal composing the casing or chest which supports and holds the various parts of such defendants' quick-action triple valves, in part form this partition, and hence the difficulty in specifying each and every part that enters into and forms a portion of the device which I call the "partition."

Defendants' experts have had considerable to say, in their depositions, regarding a partition with a restricted port or passage through it, and have designated such partition as 9, but it is manifest, upon the merest glance at plates IX and XI of defendants' 1889 and 1891 catalogues, that the part there designated as 9, which is the brass bushing before referred to, is not the "partition" which is provided with a restricted port or passage, as described by defendants' witnesses, and, so long as this is the case, it would seem that it was perfectly understood what the said partition was, and also what composed it, at least I had no difficulty in understanding what the partition was, to which defendants' experts referred as being provided with a restricted port or passage, by means of which the flow of auxiliary reservoir pressure to the brake-cylinder was restricted or retarded as described by them.

I would gladly comply with the request of counsel, if I could do so any more specifically than I have already done, but I do not see how I can. I have made the above explanation so that the difficulties of the case may be understood.

241 X Q. Do you regard the side walls of the chamber C as forming a part of the "partition" in the sense in which you use the term in your deposition?

A. No, I do not regard all of the side walls of the chamber C as a part of the partition, because it is manifest, I think, that the side walls of such chamber C may be considered distinct from such partition, that is, the particular portions of metal which go to make up the side walls of the chamber C may be omitted entirely
319 from said partition, and such partition be made up of the metal immediately adjoining such side walls and the passages leading to the auxiliary reservoir and auxiliary reservoir side of the triple-valve piston and the brake-cylinder.

This simply goes to show the impossibility of designating the specific portions of metal which I consider the "partition" before referred to, which partition, it will be remembered, is to be provided with a restricted port or passage.

242 X Q. Do you regard the walls of the port or passage governed by the valve 22 as forming any portion of the "partition" in the sense in which you use the term?

A. In the specific construction shown in defendants' quick-action triple valves, as the same are illustrated in the plates IX and XI of defendants' 1889 and 1891 catalogues respectively, the metal forming the immediate walls of the port or passage controlled by said valve 22, I would not consider as a portion of the wall or "partition" heretofore referred to.

To make my position more clear, in regard to the matter inquired about in the present question, as well as in the preceding one, I would say that the walls of the said chamber C, referred to in the preceding question, as well as the walls of the port or passage controlled by the valve 22, might be composed of an independent piece of material from that which composed the walls of the triple-valve piston chamber and the passages or ports leading to the auxiliary reservoir, and that these several parts might be so arranged, relatively to each other, that the walls of said chamber C, and port or passage controlled by the valve 22, could not form any portion of the partition before referred to, unless it might possibly be the immediate part of such walls of the chamber C which connects it with the piston chamber of the triple valve proper, and such portion might be almost infinitesimal.

243 X Q. Do you regard the said "partition," in the sense
320 in which you use the term, as functionating to divide the chamber C from the interior chamber of the brake-cylinder?

A. As I understand the present question, it would seem that that said "partition," in the sense in which I use the term, or the sense in which that term has been used by defendants' experts, is not used as functionating to divide the chamber C, which is the valve chamber, from the interior chamber of the brake-cylinder specifically, although, of course, I can conceive of constructions in which the partition would serve such a purpose, and would necessarily so serve it, because of the location of the passages leading to and from the valve chamber and the auxiliary reservoir, and from the latter to the brake-cylinder, therefore, it would depend wholly upon circumstances, whether, as a matter of fact, the said partition did functionate to divide the valve chamber from the interior chamber of the brake-cylinder.

If the question is intended to ask whether the partition provided with the restricted port or passage which restricts or retards the flow of auxiliary reservoir pressure to the brake-cylinder, is necessarily composed of any part or portion of the material which forms a partition between the valve chamber C and the interior of the brake-cylinder of said defendants' quick-action triple valves, then I would answer that I do not consider that any portion of the partition to which I have referred, and which has in it the restricted

port or passage, as stated, functionates to divide the valve chamber C from the interior of the brake-cylinder, in said defendants' quick-action triple valves.

244 X Q. From what does the "partition" separate or divide the valve chamber C, in the sense in which you use the term?

A. From the auxiliary reservoir and triple-valve piston chamber, so far as the chamber C itself is concerned.

245 X Q. Then you agree with the statement found in
321 lines 95 to 97 of page 1, of the specification of Mr. Boyden's
patent No. 381,135, where the specification states that the brass bushing 9 serves in part as a partition and separates the piston chamber D from the valve chamber C; do you not?

A. So far as the bushing 9 is concerned therein referred to, I do agree with such statement, and furthermore, have never for a moment disputed it. It will be remembered that I quoted such statement in answer to a former cross-question, explaining what I meant when I said that the "partition" was something more than simply said bushing 9, thereby giving the language of said patent in support of my understanding of what the said partition was, and that it was not composed in whole by said bushing 9.

246 X Q. Do you agree with defendants' experts, as to the purpose and function of the bushing 9, in the defendants' quick-action triple-valve apparatus?

A. I cannot say at this time whether I do or do not, for the simple reason that, as I remember their testimony at this time, it is very indefinite as to what their opinions are regarding the function of said "bushing 9."

I do remember that they state that if the bushing 9 were removed from said defendants' quick-action triple valves it would then destroy the effectiveness of the partition containing the restricted port or passage before referred to, or, at least, this is the substance, as I remember it, of their testimony.

The removal of such bushing 9, without the substitution of something else in its place, will, as I understand the matter, destroy the effectiveness of such partition, for the simple reason that it will remove a part of such partition, and thus destroy the effectiveness of it.

The making of an opening between the passage A and the piston chamber C, of the same size as said passage A, as before stated, and not removing the bushing 9, but leaving it in place, would also destroy the effectiveness of such partition, and for the same
322 reason, namely, that a portion of the partition would be removed so that there would be no longer a restricted port or passage of the character before existing.

To the extent that the removal of the bushing 9, without the substitution of something else in its place, would destroy the effectiveness of such partition, I agree with said defendants' experts.

247 X Q. Then you regard the presence of a "partition," separating the valve chamber C from the piston chamber D and the auxiliary reservoir, and provided with a restricted port or passage between the two chambers thus separated, as being necessary, in the

defendants' quick-action brake apparatus, to the performance of the quick-action function; do you not?

A. That would depend wholly upon circumstances not stated in the question, or, in other words, what the question is intended to ask and is not definitely stated therein.

The question seems to be limited to whether it is essential or material that the restricted port or opening should be specifically located between the triple-valve piston chamber D and the valve chamber C.

I do not regard it as material or essential that the restricted port or passage shall be located between the two chambers named, but, on the contrary, regard such specific location of the port or passage as wholly immaterial and non-essential, and that it might be located otherwise, relatively to the auxiliary reservoir and the chamber C.

In this connection, I will refer to Mr. Boyden's patent No. 481,135, which, it will be remembered, shows and describes the form of defendants' quick-action triple valves illustrated in plate XI of defendants' 1891 catalogue. Beginning at line 7, of page 2, of the specification of said Boyden patent, I find the following language regarding the location of this restricted port or passage. It is as follows:

> "It is obvious the restricted communication by which auxiliary reservoir air flows to the valve chamber may open directly
> 323 between the auxiliary reservoir passage A and the valve chamber, as at B', in dotted lines."

This restricted port or passage thus located is shown in figure 3 of the drawings.

From this it will be seen that the specific location of such restricted port or passage is not essential or material, and therefore, with this understanding of the question, I should have to answer that I do not regard it essential or material.

With another understanding of the question, namely, whether I regard the presence of a partition separating the valve chamber C from the piston chamber D and the auxiliary reservoir, in the specific construction shown in said defendants' quick-action triple valves, which partition is provided with a restricted port or passage, which restricts or retards the flow of auxiliary reservoir pressure into the valve chamber C, as essential and material, in such specific construction of defendants' quick-action triple valves, then I would answer that I do consider such a partition with such a restricted port or passage so located as essential or necessary to the performance of the quick-action function of said specific construction of defendants' quick-action triple valve.

Defendants' counsel states that his question was intended to have the meaning referred to by the witness in the latter part of his answer commencing with the words "With another understanding of the question," and not to have the meaning referred to in that portion of the witness's answer preceding those words.

Adjourned to Friday, December 1, 1893, at 10.30 a. m.

324 NEW YORK, *December* 1, 1893—10.30 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of HENRY F. NEWBURY resumed:

248 X Q. Do you find in the structure described and illustrated in the Westinghouse patent in suit, No. 360,070, a partition separating the valve chamber that contains the slide-valve 14 and the graduating valve 29, on the one hand, from the auxiliary reservoir and the chamber of the triple-valve piston 12, on the other hand, said partition being provided with a restricted port or passage operating to restrict the flow of auxiliary reservoir air from the auxiliary reservoir into said valve chamber? From the statement of the specification of that patent, page 2, lines 70 to 74, I understand said valve chamber containing the slide-valve 14 and graduating valve 29, to be designated as chamber 24.

Objected to as immaterial.

A. "The partition" containing the restricted port or passage referred to in the patent in suit, is not located between the auxiliary reservoir and the valve chamber 24, but is otherwise located so as to perform the same functions that are performed by the partition and restricted port, heretofore referred to in connection with defendants' quick-action triple valve.

Owing to the fact that auxiliary reservoir pressure and main air or train pipe pressure unite at a somewhat different point to enter the brake-cylinder, in the quick-action triple valve shown in the patent in suit, from what the corresponding pressures unite to enter the brake-cylinder in said defendants' quick-action triple valve, the partition with its restricted port is somewhat differently located in the two kinds of quick-action triple valves.

325 In other words, the valve chamber of said defendants' quick-action triple valve, is made a portion of the passage or conduit leading directly from the main air or train pipe to the brake-cylinder, while in the valve chamber 24, of the mechanism shown in the patent in suit, this is not the case, and therefore, the partition with its restricted port can be differently located in one mechanism or quick-action triple valve from what it is in the other, and yet, in each case, perform the same function, that is, restrict or retard the flow of auxiliary reservoir pressure, at the time when main air or brake pipe pressure is to unite with the auxiliary reservoir pressure and enter the brake-cylinder, as in a quick-action or an emergency application of the brakes.

Therefore, while the partition, with its restricted port or passage, is present in the quick-action triple valve shown in the patent in suit, yet it is not located between the valve chamber 24 on the one hand, and the auxiliary reservoir and the chamber of the triple-valve piston 12, on the other hand. In fact, in the specific construction of the quick-action triple valve shown in the patent in suit, the location of the auxiliary reservoir, valve chamber, and

triple-valve piston chamber, is such that it would be impossible to locate any kind of a partition in position relatively to the several parts, as inquired about in the question. From an examination of the specific form of construction of the quick-action triple valve shown in the patent in suit, it will be seen that the valve chamber 24 connects the triple-valve piston chamber with the auxiliary reservoir; therefore, it would take an entirely different construction and arrangement of the parts, relatively to each other, in order to separate the valve chamber on the one hand, from the auxiliary reservoir and triple-valve piston chamber, on the other hand.

249 X Q. In your answer just given, you state, in substance, that said partition containing the restricted port or passage referred to, is found in the patent in suit No. 360,070; will you please point out, in said patent No. 360,070, the partition and the restricted
326 port or passage contained in it to which you thus refer?

A. The partition, with its restricted port or passage, to which I referred in the patent in suit, is the same partition which I have heretofore pointed out in my direct examination as existing in said quick-action triple valve of the patent in suit, which partition, and its restricted port, correspond in function with the partition and restricted port found in defendants' quick-action triple valve, and to which I have heretofore referred at length. The function of the partition, and its restricted port, in each case, has to do with the third class of work, to which I have heretofore referred as emergency stops, or as quick-action or emergency-stop applications of the brakes. This function I fully explained in my direct examination.

This partition, with its restricted port, in the quick-action triple valve shown in the patent in suit, consists of the metal which divides the auxiliary reservoir, valve chamber 24, and triple-valve piston chamber 11, on the one hand, and the brake-cylinder upon the other, including, of course, the metal composing the slide-valve 14, with its restricted port or passage 35. This restricted port or passage 35 is brought into register with the port or passage 23, at the time that auxiliary reservoir pressure is to unite with main air or train pipe pressure to enter the brake-cylinder, and it is owing to the restricting or retarding of the flow of auxiliary reservoir pressure through this restricted port or opening, at that time, that the lower main air or train pipe pressure is permitted to enter the brake-cylinder, at the same time that the higher auxiliary reservoir pressure is also entering such cylinder. Or, in other words, this metal forming the partition in which the restricted port or passage 35 is located, causes the momentary differential pressures by which the lower main or train pipe air can enter the brake-cylinder at the same time that the higher auxiliary reservoir pressure is also entering it.

327 I described at length the operation of this partition and its restricted port, its location, and how it caused the momentary differential pressures in my direct examination, and will not repeat them here. It will be remembered that the specific form of quick-action triple valve shown in the patent in suit is to be attached at

its end to the auxiliary reservoir, as shown in Fig. 7 of the drawing, and this brings the auxiliary reservoir against the open end of the valve chamber 24, as the quick-action triple valve is illustrated in Fig. 2 of the drawings. The passage 23, 22, 16, 47, 48 conducts auxiliary reservoir pressure to the brake-cylinder arranged at the other end of the auxiliary reservoir, as shown in Fig. 7 of the drawings. The triple valve, auxiliary reservoir, and brake-cylinder, in such Fig. 7, are designated as 10, 6, and 7 respectively.

250 X Q. If I understand you, then, you regard the port 35, of the Westinghouse patent No. 360,070, as being itself the restricted passage through the "partition;" am I correct?

A. Yes, so far as concerns the entrance of auxiliary reservoir pressure to the brake-cylinder, when making a quick action or emergency application of the brakes.

251 X Q. In the device of said Westinghouse patent in suit, does any auxiliary reservoir air flow through said restricted passage or port 35 to the brake-cylinder, in the act of making a graduating application of the brakes or a service stop?

A. No, it does not.

252 X Q. In the defendants' apparatus, which is alleged to infringe the Westinghouse patent in suit, the auxiliary reservoir air flows through the restricted passage B, into the valve chamber C, and thence to the brake-cylinder, in the act of making a graduating application of the brakes or a service stop, as well as in the act of making an emergency or quick application of the brakes, does it not?

A. It does, because the valve chamber is made a portion of the direct passageway, conduit, or port, through which the direct admission of main air or train pipe pressure is made to the
328 brake-cylinder, and at such time, that is, when this direct admission of main air or train pipe pressure takes place, such valve chamber is in wide open communication with the brake-cylinder, and, so far as the admission of air or pressure is concerned, is a part of such brake-cylinder.

This is one of the differences, to which I have heretofore referred, between defendants' quick-action triple valves and the quick-action triple valve shown in the patent in suit, growing out of the fact that the main air or train pipe pressure and auxiliary reservoir pressure unite at a somewhat different point in one case from that at which the corresponding pressures unite in the other case.

As a matter of fact, the port 35 might be arranged in the slide-valve 14 so that auxiliary reservoir air would necessarily flow through such port, when making a graduating or service-stop application of the brakes, as well as when making a quick-action or emergency application of the brakes. I mention this fact simply to show that the location of the port 35, as it now appears in the quick-action triple valve shown in the patent in suit, might be changed from that there shown, and yet that there would be no difference in the operation of the parts as a whole, either when making a graduating service stop or an emergency application of the brakes, and without otherwise changing the mechanism.

253 X Q. In the structure of the complainants' patent No. 360,070, it is necessary that the restricted passage 35, leading from the valve chamber 24 to the brake-cylinder, be a passage through a valve or a passage controlled by a valve ; is it not?

A. In the specific form of mechanism shown in the drawings of said patent, it is necessary that the restricted port leading from the valve chamber to the brake-cylinder be a port or passage through a valve or a passage controlled by a valve, but this is due wholly to the specific form of quick action triple valves used in the drawings of said patent to illustrate the invention of the patent in suit.

329 254 X Q. In the apparatus of complainants' patent No. 360,070, why is it necessary that the passage which you term a restricted passage should be controlled by a valve?

A. Because of its specific construction, that is, the valve chamber 24 is in wide open communication with the auxiliary reservoir.

255 X Q. Is it not, rather, because the passage through which the air is admitted directly from the train-pipe to the brake-cylinder, in the act of making a quick application of the brakes, leads around the triple-valve chamber 24, and that part of the piston chamber 11 which lies between the piston 12 and the chamber 24?

A. No, I do not think it is, because the specific construction might be changed in respect to the portion of the passage inquired about, and yet have the necessity remaining (when the construction of valve chamber and auxiliary reservoir remains the same), for the port or passage to be either through a valve or controlled by a valve.

256 X Q. I shall have to ask you to make your meaning a little more clear, as I do not understand your last answer.

A. "The portion of the passage inquired about" in my previous answer referred to the portion of the passage leading around the triple-valve chamber 24 and that part of the piston chamber 11 which lies between the piston 12 and the chamber 24 referred to in the preceding question. The port or passage to be either through a valve or controlled by a valve, referred to in the latter part of my preceding answer, of course, refers to the port or passage referred to in the questions and answers which precede X Q. 255.

257 X Q. In the structure of the Westinghouse patent No. 360,070, what would be the result if, in the act of attempting to make an emergency stop, the air pressure in the valve chamber 24 should be suddenly reduced to the same extent that the air pressure in the corresponding valve chamber C of the defendants'
330 apparatus is reduced in the act of making an emergency stop
or quick application of the brakes?

A. It will be remembered that the valve chamber 24 does not correspond wholly with the valve chamber C of said defendants' quick-action triple valve, for the simple reason, as heretofore explained, that the auxiliary reservoir and main air or train pipe pressures unite in the valve chamber C to enter the brake-cylinder, while such chamber is in wide open communication with and substantially a part of the brake-cylinder, while this is not the case in

the valve chamber 24 of the quick-action triple valve shown in the patent in suit, or in other words, the valve chamber C, of defendants' quick-action triple valve, forms a portion of the passage, conduit, or port, through which the direct admission of main air or train pipe pressure is made to the brake-cylinder, while such is not the case in the quick-action triple valve shown in the patent in suit. If the air pressure in the valve chamber 24 should be suddenly reduced below the main air or train pipe pressure upon the other side of the triple-valve piston, of course the triple-valve piston would at once move forward, shutting off all communication between the auxiliary reservoir and the brake-cylinder, and at the same time opening communication between the brake-cylinder and the atmosphere and thus releasing the brake. Of course, if the triple-valve piston had been moved far enough to open the valve 41 in its backward movement, such piston, when it moved forward, as above described, to release the brakes, would permit the valve 41 to be closed by the action of the spring which moves it in one direction, namely, the closing direction.

258 X Q. It is a fact, then, is it not, that in the defendants' apparatus, the sudden and great reduction of air pressure in the valve chamber C causes the air to flow directly from the train-pipe to the brake-cylinder and effect the "quick action," whereas, in the apparatus of the patent in suit, No. 360,070, a like reduction of air pressure in the valve chamber 24, which corresponds to the
331 Boyden valve chamber C, would both defeat the quick-action application of the brakes and release the brakes?

A. The question, as I understand it, assumes that said defendants' quick-action triple valves are to remain in the same condition that they are in now, while the quick-action triple valve shown in the patent in suit is to be changed in some mysterious way, not stated, so that a result may be attained not in any way contemplated by the patent in suit, and then, the question goes on to ask me whether the operation of the two mechanisms under these conditions would not be different.

The question assumes also that the valve chamber 24 is to correspond to the valve chamber C of defendants' quick-action triple valves.

Now, if the quick-action triple valve shown in the patent in suit is to be changed in some way, so that the pressure can be suddenly reduced in the valve chamber 24, and such chamber 24 is to correspond with the chamber C of defendants' quick-action triple valve, then, under such assumption, the result would be, so far as I can see, identically the same in each case, and there would necessarily be a quick-action application of the brakes, and not any such result as would defeat a quick-action application and release the brakes, in the assumed changed construction of the mechanism shown in the patent in suit. Therefore, it is not the fact that a similar sudden and great reduction of air pressure in the assumed structure, would, in the case of defendants' quick-action triple valves, effect a quick action, and, in the assumed structure, would both defeat the quick-action application of the brakes and release them.

I cannot conceive of any mechanism, at this time, which would permit a sudden reduction in the valve chamber 24 of the quick-action triple valve shown in the patent in suit and yet not destroy the mechanism for any useful purpose whatever. At least I do not call to mind any arrangement, at this moment, which would not produce this result.

332 259 X Q. As I understand you, in the action of the mechanism described and shown in complainants' patent No. 360,070, it is not possible to produce the sudden and great reduction of air pressure in the valve chamber 24 that is produced in the valve chamber C of the defendants' alleged infringing mechanism in the act of making a quick application; am I correct?

A. You are, as I have repeatedly stated this fact both in my former deposition and the present one.

260 X Q. In the defendants' said brake mechanism, it is the partition 9, with its restricted port B, that enables the air pressure to be thus suddenly and greatly reduced in the valve chamber C; is it not?

A. Understanding "the partition 9" to be the partition as I have heretofore explained, I will answer the question. It is the presence of a partition which may be designated as 9, with a restricted port or passage placed therein, which partition is located relatively to the auxiliary reservoir and piston chamber D, relatively to the brake-cylinder, as contained in said defendants' quick-action triple valves, which permits or enables the air pressure to be suddenly and greatly reduced in the valve chamber C of said defendants' valve, which chamber, as heretofore explained, is, at that time, in wide open communication with the brake-cylinder, and is also used as a portion of the direct communication between the main air or train pipe and the brake-cylinder.

The only time it is desired to greatly and suddenly reduce the pressure or air in the valve chamber C, is when the direct admission of pressure from the main air or brake pipe to the brake-cylinder is to be made, and, at this time, the chamber C is not serving the function of a valve chamber, but it is serving the function of admitting main air or train pipe pressure directly to the brake-cylinder, and, so far as such admission of main air or train pipe pressure directly to the brake-cylinder is concerned, the chamber C forms only a part of the passageway, conduit, or port, by means of which such direct admission of pressure is made.

333 It is true, as I have repeatedly stated, that the restricted port or opening in said partition at this particular time, serves the function of restricting or retarding the flow of auxiliary reservoir pressure to the brake-cylinder, so that the direct admission of main air or train pipe pressure can take place, and its only function is to so retard and restrict the flow of auxiliary reservoir pressure to the brake-cylinder at such time. It is of no use at any other time, and, therefore, when the said chamber C is serving its function of a valve chamber, the restricted port and partition is inert, and is only brought into useful work when said chamber C is serving the function of forming a part of the passageway, conduit, or port, from the

main air or train pipe to the brake-cylinder, by means of which the direct admission of air or pressure takes place from the former to the latter.

With this explanation, I would answer that it is the partition 9, with its restricted port B, that enables the air pressure to be suddenly and greatly reduced in the valve chamber C. Of course, it being remembered that, at this time, the valve chamber C is serving the function of a portion of the direct communication between the main air or train pipe and the brake-cylinder.

261 X Q. I understand from your last answer, that in the Boyden apparatus, the chamber C performs two functions, viz., the function of accommodating those valves which control the admission of air from the auxiliary reservoir to the brake-cylinder, and the function of forming a passage, or a portion of a passage, through which air is admitted directly from the train-pipe to the brake-cylinder in making the quick application of the brakes; do you find in the apparatus of the complainants' patent, No. 360,070, any chamber which performs these two functions?

A. I do not find in the mechanism shown in the patent in suit No. 360,070 any chamber performing the two functions named.
334 If I remember correctly, I have heretofore repeatedly pointed out this difference between the two kinds of quick-action triple valves.

262 X Q. In the defendants' alleged infringing mechanism, if the bushing 9 were omitted, would the sudden and great reduction of air pressure in chamber C, which causes the air to flow directly from the train-pipe to the brake-cylinder and effect the "quick action" in the apparatus as actually used with the bushing in place, then, in the absence of such bushing, cause the air to flow directly from the train-pipe to the brake-cylinder, and thus effect the "quick action"? In other words, in the defendants' brake apparatus illustrated in plate XI of their 1891 catalogue, would the sudden and great reduction of air pressure in valve chamber C which, as the apparatus is there shown, effects the "quick action," have the effect to cause the air to pass directly from the train-pipe to the brake-cylinder, in case the bushing 9 were omitted or removed?

A. As I understand the question, it is as follows: Would the removal of the bushing 9, shown in plate XI of defendants' 1891 catalogue, prevent the sudden reduction of pressure in the chamber C, which now takes place when such bushing is in place?

With this understanding of the question, I should answer that the sudden reduction in pressure which takes place when the said bushing 9 is in place, would not occur when said bushing was removed, and that this difference in the reduction of pressure in the chamber C is sufficient to prevent a direct admission of main air or train pipe pressure to the brake cylinder, through such chamber C, and, because of this, the "quick action" would not occur. The term "quick action," as used by me, and as I understand it to be used in the question, refers to the quick-action or emergency application of the brakes, wherein a direct admission of main air or train pipe pressure to the brake-cylinder takes place.

263 X Q. Assuming the bushing 9 to have been removed from the apparatus used by defendants, and illustrated in plate
335 XI of their 1891 catalogue, state what would be the action of the apparatus upon the engineer's making such reductions of pressure in the train-pipe as he would ordinarily make in graduating; also as he would ordinarily make in applying the service stops; and, thirdly, as he would ordinarily make in attempting to stop the train in the shortest possible time or, in other words, in an emergency stop?

A. As I understand the question, it refers to the three classes of work which I defined in my former deposition, and which have been designated, by defendants' expert, as graduating, service-stop, and quick-action or emergency application of the brakes.

I should expect that the two first classes of work would be performed in substantially the same way, when the bushing 9 was removed, that such two classes are performed when such bushing is present. Of course, assuming that the triple-valve piston stem is provided with some means of properly guiding it back and forth, when moved by varying the pressures upon the two sides of the piston.

I should also expect that the third class of work would not be performed at all when the bushing 9 was removed.

I have had tests made with a quick-action triple valve, very similar to the one illustrated in plate XI of defendants' 1891 catalogue, and found that, with a single valve, the results were as above stated, and I should expect that the results would be as stated when quick-action triple valves, like those shown in plate XI of defendants' catalogue 1891, were placed upon each car of the train, with the bushing 9 removed, and the engineers' valve or cock manipulated in the ordinary way for performing the three classes of work heretofore referred to.

264 X Q. Then, if I understand you, the apparatus illustrated in plate XI of defendants' 1891 catalogue, in the absence of the bushing 9, would operate as a plain triple valve; am I correct?
336 A. You are, for the reason that the bushing 9, as heretofore explained, forms a part of the partition with the restricted port or passage, which is essential in quick-action triple valves, as before explained by me.

265 X Q. In your answer to X Q. 249 this morning, you undertook to point out or explain what you called the partition, with its restricted passage, in the structure illustrated in the Westinghouse patent in suit, No. 360,070; in that so-called partition of the Westinghouse structure, is there any part forming a portion of said partition which you can destroy or remove, and still have the apparatus perform all the functions of a plain triple valve.

A. Yes, I believe there is.

266 X Q. What is such part?

A. That part or portion which would be uncovered when the slide-valve 14 is in position to have the triple-valve piston open the valve 41, and which would be closed when said valve 14 was in

position to make a graduating and service-stop application of the brakes.

This would, in effect, give a pressure in the passageway, conduit, or port, leading directly from the main air or train pipe to the brake-cylinder, that would be high enough to overcome such main air or train pipe pressure and prevent its direct admission to the brake-cylinder.

267 X Q. Do you mean that you could make a hole through the casing, from the valve chamber 24 to the passage 46, in the Westinghouse apparatus shown in the patent in suit?

A. That is substantially what I mean, such hole being of somewhat greater capacity than the passage 46, so that there would be substantially the same pressure in the passage 46 that there is in the auxiliary reservoir or valve chamber 24.

268 X Q. Assuming such a hole, larger in area than the cross-section of the passage 46, to be made through the wall or casing of the triple-valve chamber 24 to the passage 46, where would you locate that hole in order to have it in position to be uncovered when the slide-valve 14 is in position to have the triple-valve
337 piston open the valve 41, and so that it would be closed when said valve 14 was in position to make a graduating and service-stop application of the brakes?

A. I would locate the said hole as described in a previous answer, which is as definite as I can locate it at the present time, that is, I would so locate such hole that it would be covered when the slide-valve 14 is in position for making a graduating and service-stop application, which, it will be remembered, is one and the same position, and also, so that such hole would be uncovered by the slide-valve 14 when the valve 41 is opened.

269 X Q. Can you not refer to figure 2 of the drawings of patent 360,070, which shows said slide-valve, and the wall or casing upon which it slides, illustrated in section, and point out just where you would locate that assumed hole?

A. The said figure 2, it will be observed, is taken on a section line which does not show the passage 46, and for this reason any designating mark that I might put on said figure 2 might be misleading, and furthermore, would not show the capacities of the hole and passage, as that would depend upon something which it is impossible to show on said figure 2.

270 X Q. You state that the hole would be so arranged as to be uncovered when the slide-valve 14 is in position to have its piston open the valve 41, and would be covered when the said valve 14 was in position to make a graduating and service-stop application; when the slide-valve 14 was in the latter position, covering the imaginary hole, the "partition" would be intact and no part of it removed so as to allow communication between the chamber 24 and the passage 46, would it not?

A. The partition would have a part of it removed, as much as would the partition in said defendants' quick-action triple valve when the bushing 9, which makes up a part of the partition of said

defendants' quick-action triple valve, at the time that the
338 said defendants' valves were to be used when making a quick-action application of the brakes was removed, and the removal of the part of the partition of each quick-action triple valve produces a similar result, that is, preventing the direct admission of main air or train pipe pressure to the brake-cylinder, by reason of the higher auxiliary reservoir pressure existing in the passageway, conduit, or port, through which such direct admission of pressure takes place.

In each case auxiliary reservoir pressure must be shut off from the brake-cylinder, except through the port by which the graduating and service-stop application of the brakes must be made; therefore, the partition in the quick-action triple valve shown in the patent in suit, with the assumed hole, would not be intact and no part of it removed, because, if such was the fact, there would be no change whatever in the operation of the mechanism from what it is as shown in said patent.

It is true that the auxiliary reservoir pressure is cut off from the brake-cylinder, when a graduating and service-stop application of the brakes is to be made by the covering of such hole with the slide-valve 14, but, notwithstanding this fact, the "partition" is not intact, and an essential and material portion of it is removed.

271 X Q. But you state that, during the operations of graduating and making service stops, you would have the valve 14 cover your imaginary hole, so as to prevent air from passing through it from chamber 24 to passage 46; during such time, when the hole was so covered by the valve, your so-called "partition" would be just as complete and effective as a partition, as if the hole did not exist, would it not?

Adjourned to Saturday, December 2, 1893, at 10.30 a. m.

339 NEW YORK, *December* 2, 1893—10.30 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of HENRY F. NEWBURY resumed:

A. to X Q. 271. What counsel is pleased to term my "so-called partition" is, as has been repeatedly explained, a partition with a restricted port or passage, which partition, with its port or passage, is located between the auxiliary reservoir and the brake-cylinder, and is useful only, so far as the restricted port or passage is concerned, during the time that a quick-action or emergency application of the brakes is to be made.

In order that the quick-action triple valve shown in the patent in suit shall be of any use whatever in applying the brakes, the auxiliary reservoir must be, at least when making a graduating or service-stop application, separated from the brake-cylinder, except by the usual connections, otherwise the mechanism would be entirely worthless for any useful purpose that I call to mind at this time.

In this respect, there is no difference whatever between the quick-action triple valve shown in the patent in suit and defendants' quick-action triple valve shown in plates IX and XI in defendants' 1889 and 1891 catalogues respectively.

The "imaginary hole" which removes the restricted port or passage from the partition in the mechanism shown in the patent in suit, would not be just as complete and effective as a partition as it would be if that hole did not exist, and, so far as the restricted port or opening is concerned, by means of which a quick-action application of the brakes is made, the partition is effectually removed at the only time that the restricted port or opening serves its function.

It is true that this imaginary hole is covered, at the time when the graduating or service-stop application is to be made, and
340 this is done by the movement of one part relatively to
another, but this is also the case in said defendants' quick-action triple valve, so far as concerns the separation of the brake-cylinder from the auxiliary reservoir, which is the essential function of the partition with its restricted port or passage.

In each case, if the brake-cylinder were not separated from the auxiliary reservoir by a movable part, said defendants' quick-action triple valve would be as useless, for any purpose that I know of, as would be the case with the quick-action triple valve shown in the patent in suit, if the said imaginary hole were made without any provision for covering it, and thus separating the brake-cylinder from the auxiliary reservoir.

These several facts simply emphasize the similarity between the quick-action triple valve shown in the patent in suit and said defendants' quick-action triple valve, as well as illustrate the fact that, the partition with its restricted port or passage, of the mechanism shown in the patent in suit, is not as effective and complete, for the purposes which it is to serve, when the "imaginary hole" referred to in the question is present therein, as such partition and its restricted port are when the said hole is absent.

272 X Q. In the mechanism illustrated in defendants' 1891 catalogue, plate XI, if the bushing 9 be removed totally and permanently, you have testified that the apparatus will operate as a plain triple valve, but will not operate to produce "quick action." I asked you if there was any such partition in the apparatus of complainants' patent No. 360,070 which could be removed with like result. You replied that the imaginary hole which you have tried to describe could be made through the casing of the chamber 24, and so arranged relatively to the valve 14 that it would be exposed when said valve was in a position to make a quick application, and covered when said valve was in a position to make a graduating or service-stop application. In other words, you try to describe a partition which can be removed at one portion of the movement of the valve, and restored by another portion of the movement
341 of the same valve. Now I ask you whether, in the apparatus
of the patent in suit, you find any partition or part of the partition that can be permanently removed and allowed to remain

removed, (just as the bushing 9 of the Boyden apparatus can be removed and allowed to remain removed) with the result that the said Westinghouse apparatus will then be capable of performing all the functions of a plain triple valve, but will not be capable of performing the quick-action function?

By the words "such partition," in the second sentence of this interrogatory, I mean any part forming a portion of your so-called partition in the apparatus of patent 360,070, which you can destroy or remove with like results as follows from the destruction or removal of the bushing 9 of the Boyden apparatus.

A. The statements which precede the question do not seem to me to be correct statements of the facts. I will call attention to the statement, wherein it says, in substance, I "try to describe a partition which can be removed at one portion," &c.

I not only tried to describe such a portion, but I think, as a matter of fact, I did describe it.

I also believe that I have already fully answered the present question, but have not the slightest objection to answer it over again, and will do so in different language.

The "bushing 9" heretofore referred to in connection with said defendants' quick-action triple valves, and the removal of which prevents said defendants' quick-action triple valve from making a quick-action or emergency application of the brakes, is simply a part of the partition provided, with the restricted port or passage, to which I have heretofore referred. The removal of such bushing 9 removes a portion of such partition in the immediate vicinity of said restricted port or passage, so that the opening which formed this port or passage is no longer capable of restricting or retarding the flow of auxiliary reservoir pressure in its passage
342 or expansion into the brake-cylinder, owing to the fact that a larger opening has been made in its immediate vicinity.

The quick-action triple valve shown in the patent in suit, as I have heretofore explained, contains a partition with a restricted port or opening, which port or opening serves to restrict and retard the flow of auxiliary reservoir pressure, in its passage from the auxiliary reservoir to the brake cylinder, when making a quick-action application of the brakes.

The removal of that part or portion of the partition, in the mechanism shown in the patent in suit, in the immediate vicinity of the restricted port or passage through such partition, and by such removal forming an opening into the passage 46 shown in said patent, which opening was to be of larger capacity than said passage 46, likewise produced an opening in the partition, by the permanent removal of a part of that partition, and such removal rendered the restricted port or passage incapable of restricting or retarding the flow of auxiliary reservoir pressure to the brake-cylinder, in precisely the same manner, and for precisely the same reasons that the removal of the bushing 9, in said defendants' quick-action triple valves, rendered the restricted port or passage of those valves, designated as B in plate XI of defendants' 1891 catalogue, ineffectual to restrict or retard the flow of auxiliary reservoir pressure to the

brake-cylinder of those quick-action triple valves, when making a quick-action or emergency application of the brakes.

The removal of the part of the partition, in one case, is as permanent and thorough a removal as it is in the other case, and the result is the same in each case, and one apparatus will be as capable of performing the functions of the plain triple valve as the other will, and because of the same reasons.

Because of these facts, I do find a part or portion of the partition containing the restricted port or passage in the quick-
343 action triple valve shown in the patent in suit which can be permanently removed and be allowed to remain removed (just as the bushing 9 of the Boyden apparatus can be removed and allowed to remain removed) with the result that the said Westinghouse apparatus, or the apparatus shown in the patent in suit, changed as I have suggested, will then be capable of performing all of the functions of a plain triple valve, but will not be capable of performing the quick-action or emergency application of the brakes.

273 X Q. You speak of removing a part of your so-called partition, by forming the imaginary hole, and then you immediately proceed to cover the hole by the valve 14, during the graduating and service-stop position of said valve; does not the covering of the hole restore the partition and hold it restored while the valve is in position to make a graduation or service-stop application?

A. "The partition" to which you have been referring all the time, is a partition with a restricted port or opening, and to separate the restricted port or passage from the partition so that it is no longer the partition to which we have been referring, is to make a different partition altogether from the one containing such restricted port or passage.

This fact shows that the valve 14, in its movement, does not destroy "the partition," during the graduating and service-stop applications of the brakes, and therefore, the covering of the opening made by the permanent removal of a part of said partition, which opening counsel is pleased to term "the imaginary hole," does not restore such partition for the graduating and service-stop applications of the brakes.

The covering of this opening, made by the permanent removal of a part of the partition, is done by the usual movements of the mechanism, when performing the said graduating and service-stop applications of the brakes, and the most that can be said of it is, that it renders the apparatus serviceable while making such applications of the brakes, the same as the closing of chamber C
344 from the brake-cylinder in said defendants' quick-action triple valves, by the ordinary movements of the parts in those mechanisms, renders them serviceable while making corresponding applications of the brakes. In each case, the closing of communication between the auxiliary reservoir and the brake-cylinder is by the ordinary movements of the other parts of the two kinds of mechanisms, and the permanent removal of a part of the partition containing the restricted port or passage, does not, in any way, affect

either kind of mechanism, when making a graduating or service-stop application of the brakes.

Of course, all of my references to the operation of the said defendants' quick-action triple valves, are to said valves when the "bushing 9" is removed, and said valves are operated as I have seen them operated, that is, so that the graduating and service-stop applications of the brakes are made without the opening of the valve 22, and also as they necessarily would have to be operated if such valves were operated by the use of an engineers' valve or cock of the ordinary construction and in the ordinary way.

274 X Q. You have delivered a long lecture, but have not answered my question, and I now repeat it: Does not the covering of the hole, which you have imagined in the casing of the Westinghouse apparatus, restore the partition, and hold it restored, while the valve 14 is in position to make a graduation or service-stop application?

A. I beg to differ with counsel as to his statement of the fact. I have fully answered his question, as I understand the matter, wherein I said "The covering of the opening made by the permanent removal of a part of said partition, which opening counsel is pleased to term 'the imaginary hole' does not restore such partition for the graduating and service-stop applications of the brakes."

Notwithstanding the fact that I have already answered the question once, I have no objection to answering it again, and will do so using different language.

345 The movement of the valve 14, by means of which the opening, which I have assumed to be made in the partition containing the restricted port of the mechanism shown in the patent in suit is closed, does not restore such partition and hold it restored, in such apparatus, while the valve 14 is in position to make a graduating or service-stop application of the brakes, and, for the very manifest reason, that the restricted port is not effective for restricting or retarding the flow of auxiliary reservoir pressure to the brake-cylinder, when a quick-action or emergency application of the brakes is to be made, that is, the movement of the valve 14 has nothing whatever to do with restoring the restricted port or passage to its functions in the said partition, and has nothing whatever to do with the restoration of a partition with such a restricted port or passage.

275 X Q. When you make a hole through a partition, and then cover and close the hole, do you not thereby, in effect, restore the partition and hold it restored so long as the cover remains in place to close the hole?

A. The present question seems to deal wholly with an abstract proposition, which has nothing whatever to do with the present case, so far as I understand the question.

Considering the matter wholly as an abstract proposition, I should have to answer that the question does not state facts enough to determine whether, in effect, the partition would be restored, and held restored, or not.

If the question is only intended to ask whether the hole in the assumed partition would be covered and closed, I should, of course, answer that it would, but whether the partition assumed in the question would be in effect restored or not, I am unable to state, until I see the mechanism in which that partition is located and know the functions of the partition.

276 X Q. If your imaginary hole in the partition, as you call it, of the Westinghouse apparatus of patent No. 360,070, were
346 not closed during the making of a graduation or service stop, would said brake apparatus perform the functions of a plain triple valve or not?

A. No, as I have repeatedly heretofore stated.

277 X Q. Then the imaginary hole which you would make in the so-called partition of the apparatus shown in the patent 360,070, is a hole which must be closed during the making of a graduation or service stop, and opened by the movement of the triple-valve piston to its extreme outward position, in order that said Westinghouse apparatus, with such assumed hole shall perform all the functions of a plain triple valve and not perform the quick-action function; am I correct?

A. The opening which I have assumed to be made by the permanent removal of a part of the partition provided with the restricted port or passage, of course is placed in such part of the said partition that it will not destroy the mechanism for any useful purpose whatever, as the same is illustrated in the patent in suit.

This is the case when we make a permanent removal of the "bushing 9" of said defendants' quick-action triple valves.

If this was not the case with both kinds of triple valves, then both mechanisms would be worthless for any useful purpose, and this is as true of one kind of mechanism as it is of the other.

The location of the opening at the particular point named by me, was due wholly to the specific details of construction of the mechanism used to illustrate the invention of the patent in suit.

In a mechanism having the specific details of construction of the mechanism shown in the patent in suit, and with the partition and the restricted port or passage, located relatively to the auxiliary reservoir, valve chamber 24 and piston chamber 11 on one hand, and the brake-cylinder on the other hand, as there shown, the part of such partition which is to be permanently removed in the formation of the opening, as described by me, is necessarily to be located so
347 that it will not interfere with the performance of the two first classes of work heretofore referred to by me, and to do this, such opening would also have to be located so that, in the ordinary operations of the mechanisms, the auxiliary reservoir would be shut off from the brake-cylinder except by the connections provided by means of which the graduating and service-stop applications of the brakes are made, and this requires that such hole or opening must be closed at the time when a graduating or service-stop application of the brakes is to be made.

Or, to state the matter in other words, the partition, with its restricted port or passage, in the mechanism shown in the patent in

suit, not only serves to separate the auxiliary reservoir and auxiliary reservoir side of the piston chamber from the brake-cylinder, but also serves to separate the valve chamber 24 from the brake-cylinder. Consequently, the restricted port or passage through such partition has to be closed, whenever a graduating or service-stop application of the brakes is to be made, and also when the brakes are off, and any part or portion of such partition which is to be permanently removed, must be located so that the opening made by such removal will be likewise closed when the brakes are to be off, and also when graduating and service-stop applications of the brakes are to be made.

This would not necessarily be the case if the auxiliary reservoir valve chamber 24, triple-valve piston 12, piston chamber 11, and brake-cylinder, were arranged somewhat differently from what they are now arranged, but still operating to perform the same work, in substantially the same way that the work is now performed, when these several parts are specifically arranged as shown in the patent in suit.

It will be observed that, in said defendants' quick-action triple valves, the auxiliary reservoir is shut off from the brake-cylinder, except by the connections provided by means of which a graduating or service-stop application of the brakes is to be made, at the time that the "bushing 9" is removed, and also, that the
348 part which shuts off the auxiliary reservoir from the brake-cylinder, as thus set forth, namely, the valve 22, is wide open when an emergency or quick-action application of the brakes is to be made, and is so opened by the ordinary movements of the mechanism, and also, that such opening is closed again, by the ordinary movements of the mechanism, when the brakes are to remain off, and also when a service-stop or graduating application of the brakes is to be made, in order that said defendants' quick-action triple valves shall perform all of the functions of a plain triple valve, and also that this port, controlled by the valve 22, is opened by the movement of the triple-valve piston to its extreme outward position, at which time the quick-action function will not be performed.

With the above explanations, you are correct.

Answer objected to by defendants' counsel, as containing a mess of rubbish, totally irresponsive to the question.

278 X Q. The hole made in the Boyden apparatus by the removal of the bushing 9 does not have to be covered or closed during the graduating or service-stop application of the brakes, does it?

A. In effect it is closed, but not literally closed. That is, the portion of the partition which is removed is so located, relatively to the other parts, that it does not have to be literally covered when making a graduating or service-stop application of the brakes, but it does have to be covered, in effect, by the valve 22, so that such opening does not lead directly into the brake-cylinder.

In one form of defendants' quick-action triple valves, an opening could be made in the partition provided with a restricted opening,

which would necessarily have to be literally closed by the movements of the triple-valve piston, if the mechanism was to
349 serve any useful purpose and be able of serving the functions of a plain triple valve.

I mention this fact simply to show that the real difference between the two structures, namely, said defendants' quick-action triple valve and the one shown in the patent in suit, is not an essential difference, and is wholly due to the specific form given to the parts.

279 X Q. You state that, in one form of defendants' quick-action triple valves, an opening could be made in the partition provided with restricting openings, which would necessarily have to be literally closed by the movements of the triple-valve piston, if the mechanism was to serve any useful purpose and be capable of serving the functions of a plain triple valve; what form of defendants' quick-action triple valves do you refer to here?

A. I refer to the form illustrated in plate IX of defendants' 1889 catalogue.

280 X Q. Please explain more particularly where, in that form of defendants' apparatus, you would make the opening to which you refer, and describe the opening which you would thus make?

A. I would remove a portion of the partition containing the restricted port or passage, which lies between the passage A (*b*) of said plate IX of defendants' 1889 catalogue, and the port closed by the "plug" valve 22 (15). The portion of said partition so removed, would be sufficient to make an opening of greater capacity than the openings *h h*, leading into the brake-cylinder from the port closed by said "plug" valve 22 (15). This would require such opening to be closed by the movements of said "plug valve" 22, the same as would be the case when the portion of the partition containing the restricted port or passage in the quick-action triple valve shown in the patent in suit, was removed as heretofore described by me.

281 X Q. Why do you restrict that hole to one form of defendants' apparatus, namely, the form shown in plate IX of the
350 1889 catalogue? If a similar hole were made at the same point, in the apparatus shown in plate XI of defendants' 1891 catalogue, would not all the results be substantially the same as with the hole made at the same point in the apparatus shown in plate IX of the 1889 catalogue?

A. I make no restriction whatever in the matter. I simply stated the fact in connection with the quick-action triple valve shown in plate IX of defendants' 1889 catalogue. That is, the fact that the same kind of an opening could be made in the quick-action triple valve shown in the 1889 catalogue that was made in the mechanism shown in the patent in suit, and with the same results.

As a matter of fact, a similar hole or opening, made at a corresponding point in the quick-action triple valve shown in the plate XI of defendants' 1891 catalogue, would render that apparatus entirely worthless for any useful purpose, and consequently the results would not be substantially the same, in the case of the quick-action triple valve shown in plate XI of defendants' 1891 catalogue, as

they would be with the quick-action triple valve shown in plate IX of defendants' 1889 catalogue. That is, in the case of the apparatus of the 1889 catalogue, such apparatus would serve all the functions of a plain triple valve, or a triple valve proper, while, in the case of the apparatus of the 1891 catalogue, this latter apparatus would be utterly worthless for any useful purpose whatever.

I mentioned this fact of making the opening in the quick-action triple valve shown in plate IX of defendants' 1889 catalogue, at the point between the passage A (*b*) and the port controlled by the valve 22 (15), simply to illustrate the fact that the specific form given to the parts, made the difference between the quick-action triple valve shown in the patent in suit, when provided with the opening as described by me, and said defendants' quick-action triple valve when the "bushing 9" was removed therefrom. Or, in other
351 words, that the difference between the said defendants' quick-action triple valves, with the bushing 9 removed, and the quick-action triple valve shown in the patent in suit, with the opening made as described by me, was a difference arising wholly out of minor specific details of construction, and not to any difference in the principle of operation of the several quick-action triple valves.

282 X Q. Why would the apparatus shown in plate IX of defendants' 1889 catalogue, and the apparatus shown in plate XI of defendants' 1891 catalogue, operate differently, in case that each had a hole such as you describe made from the passage A (*b*) to the port controlled by the plug valve 22 (15)?

A. The reason why the quick-action triple valves of the said two catalogues would act differently is, that in the quick-action triple valve shown in plate IX of defendants' 1889 catalogue, the opening, which I have described as being made, would be closed by the ordinary movement of the "plug" valve 22 (15), by the ordinary movements of the triple-valve piston when the brakes were "off," and also when a graduating or service-stop application of the brakes was to be made, while, in the quick-action triple valve shown in defendants' 1891 catalogue, such opening could never be closed by the ordinary movement of the valve 22 of said quick-action triple valve, and such opening would always remain open, and the brake-cylinder and auxiliary reservoir would always be in open communication, one with the other.

This open communication of the auxiliary reservoir and brake-cylinder, at all times, would prevent any storing of air or pressure in the auxiliary reservoir, because the auxiliary reservoir would be in open communication with the atmosphere through the brake-cylinder, and the apparatus would be wholly worthless for any useful purpose.

The closing of the corresponding opening in the quick-action triple valve shown in plate IX of defendants' 1889 catalogue, by the ordinary movements of the "plug" valve 22 (15), would
352 render such quick-action triple valve capable of performing all of the functions of a plain triple valve and such opening would only prevent such quick-action triple valve from performing

the quick-action function. In the case of the latter quick-action triple valve, the auxiliary reservoir and brake-cylinder would not always be in open communication, and would only be in open communication at the times necessary for a graduating or service-stop application of the brakes, and then only by the usual connections used for this purpose. Of course, I do not here include the attempt to make a quick-action or emergency application of the brakes, which, as before explained, would be defeated by reason of the opening leading from the auxiliary reservoir to the port controlled by the "plug" valve 22 (15)?

The drawing composing plate IX of said defendants' 1889 catalogue, is simply a cross-sectional view of the quick-action triple valve there shown, and the passage A (*b*) is shown as to only one of its dimensions, but I have assumed that the dimensions of said passage, in the direction not shown, are such as to correspond with the corresponding passage of plate XI of defendants' 1891 catalogue. Or, in other words, that the capacity of the passages is substantially the same.

283 X Q. As I understand you, then, the making of a hole, such as you describe, leading from the passage *b* to the seat of the valve 15, in defendants' apparatus shown in plate IX of defendants' 1889 catalogue, so that said hole would be closed and opened by said valve 15, would be, in all respects, the equivalent of the making of your imaginary hole, in the apparatus of the patent in suit, leading from the passage 46 to the seat of valve 14, and closed and opened by the movements of said valve 14; is my understanding correct?

A. It is, or, in other words, the making of the opening or hole, as described by me, leading from the passage A (*b*) to the port controlled by the "plug" valve 22 (15), is in all respects the
353 equivalent of removing the "bushing 9" of the quick-action triple valve shown in plate IX of defendants' 1889 catalogue.

284 X Q. The removal of the bushing 9, however, leaves a hole which is not controlled by a valve, whereas the making of the holes which you have imagined or assumed in the apparatus of the patent in suit, and the apparatus of the defendants' 1889 catalogue, produces a hole which does require to be opened and closed by a valve: am I not correct?

A. No, I do not think that you are, for in each case the hole or opening made has to be in effect controlled by a valve. For instance, take the quick-action triple valve shown in plate IX of defendants' 1889 catalogue; when the "bushing 9" is removed, the connection between the reservoir and brake-cylinder thus made has to be controlled, so far as the making of a graduating or service-stop application of the brakes is concerned, by the said "plug" valve 22 (15), and when the opening is made, between the passage A (*b*) and the port controlled by the "plug" valve 22 (15), it has to be likewise controlled by the same "plug" valve 22 (15), or, in other words, in each case the opening made between the auxiliary reservoir and the brake-cylinder has to be in effect controlled by a valve, so that such opening will be closed at the times heretofore stated,

viz., when the brakes are "off," and also when a graduating or service-stop application of the brakes is to be made, and, so far as the function of the opening made by a removal of a part of the partition containing the restricted port or passage is concerned, the result is identically the same in each case, and any difference in the way or manner of controlling such opening, whether it be by the removal of the bushing 9, or the removal of another part of said partition, as just described, is wholly owing to the removal of different parts of the same partition and not to any other fact.

In this connection, I would state that when the opening described by me is made between the said passage A (*b*) and the port
354 controlled by the "plug" valve 22 (15), of plate IX of defendants' 1889 catalogue, it is wholly immaterial, so far as concerns any of the other operations of said mechanism, whether the "bushing 9" be left in place or be removed from such mechanism.

Adjourned to Monday, December 4, 1893, at 10.30 a. m.

New York, *December* 4, 1893—10.30 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of Henry F. Newbury resumed:

285 X Q. If I understand you correctly, the valve 14, in conjunction with your imaginary hole, in the apparatus of the Westinghouse patent in suit, would perform the same functions as the valve 22, in conjunction with its port, in the apparatus of plate XI of defendants' 1891 catalogue. If such be the fact, the one arrangement or combination, (including the slide-valve 14 and its imaginary hole), is the equivalent of the other arrangement or combination, (including the valve 22 and its port): is this true?

A. Whether you understand me correctly or not, depends upon what you mean by the words "the same functions." If, by those words, it is to be understood that they refer only to the closing of the communication between the auxiliary reservoir and brake-cylinder, at the time or times when a quick-action or emergency application of the brakes is *not* to be made, and to this extent only, then your understanding would be substantially correct. If, on the other hand, the words "the same functions" are to have any other meaning than the one just stated, your understanding is not entirely correct.

355 It is true, to the extent above indicated, that the one arrangement or combination is the equivalent of the other arrangement or combination, that is, to the extent of closing communication between the auxiliary reservoir and the brake-cylinder, at the time or times when quick-action or emergency applications of the brakes are not to be made.

Of course, there may be other points of similarity between the two arrangements or combinations, that I do not think it necessary to refer to at this time.

286 X Q. For the purpose of making a service stop, or a graduated application of the brakes, the two arrangements referred to in my last question would be equivalents, would they? I assume, of course, that the bushing 9, of the Boyden apparatus, be removed.

A. This question, like the preceding one, depends wholly upon the understanding given to the language used, whether the answer shall be yes or no. That is, the language is broad enough to include points of equivalency which would require an answer one way, and then, with a more limited understanding of the term "equivalents," the answer would be directly opposite.

To the extent mentioned in my preceding answer, the two arrangements referred to would be equivalents, and substantially to that extent alone, and, with this understanding, I should answer yes.

On the other hand, if the language of the question is given its ordinary meaning, then the two arrangements would not be the equivalents one for the other, for the simple reason that the valves 14 and 22 perform entirely different functions, in the two combinations or arrangements, when a graduating application of the brakes is to be made. For instance, the valve 14 has to close communication between the brake-cylinder and the atmosphere, when a graduating application of the brakes is to be made, while the valve 22, on the other hand, cannot perform this function. Again, the valve 14 has to be still further moved, so as to open communication
356 between the auxiliary reservoir and the brake-cylinder, in order that a graduating application of the brakes be made, while, on the other hand, the valve 22 cannot be moved at such times, and, therefore, cannot perform this function which is performed by the valve 14.

Furthermore, if the graduating application of the brakes, referred to in the question, includes the release of the brakes, as it would naturally be assumed to include, then the valve 14 has to be moved so as to open communication between the brake-cylinder and open air, in order that a release of the brakes be made, and this is a function which the valve 22 cannot, by any possibility, perform.

From this it will be seen that, taking the two arrangements or combinations as a whole, without any more qualification than is made in the question, such two arrangements would not be the equivalents one for the other.

287 X Q. In your last answer you state that the valve 14 has to be still further moved, so as to open communication between the auxiliary reservoir and brake-cylinder, in order that a graduating application of the brakes be made; does such further movement of the valve 14, in and of itself alone, open communication between the auxiliary reservoir and the brake-cylinder, to make a graduating application of the brakes, or does such graduating application require not only that the valve 14 be so further moved, but also that the graduating valve 29 be moved independently of the valve 14, so as to open its port and establish communication between the auxiliary reservoir and the brake-cylinder? And is not the function of actually opening such communication performed by the

alve 29 instead of the valve 14, in the apparatus of the patent in uit?

A. At the time spoken of by me in my previous answer, all that s required for the admission of auxiliary reservoir pressure to the rake-cylinder, in the making of a graduating application of the rakes, is simply the further movement of the slide-valve 14, and there is no independent movement of the valve 29, relatively
357 to the slide-valve 14, so far as the admission of auxiliary reservoir pressure to the brake-cylinder at this time is concerned.

So far as concerns the admission of auxiliary reservoir pressure o the brake-cylinder, the valve 29 has an independent movement elatively to the slide-valve 14, before the slide-valve can have any novement whatever to close communication between the brake-ylinder and the atmosphere, hence, at the time of admitting auxiliary reservoir pressure to the brake-cylinder, to make a graduating application of the brakes, it requires simply the further movement of the slide-valve 14. It is true that the graduating valve 29 is connected to the triple-valve piston, so that, whenever the triple-valve piston moves the slide-valve 14, the valve 29 must move in unison with the valve 14, and the only time that the valve 29 has an independent movement relatively to the slide-valve 14, is at such time as the valve 14 does not move with the triple-valve piston, but is stationary while the triple-valve piston moves.

It is also true that when a graduating application of the brakes is to be made, the valve 29 has an independent movement relative to the slide-valve 14, in order to shut off communication and stop the flow or admission of auxiliary reservoir pressure to the brake-cylinder. Or, in other words, so far as concerns the limiting of the amount of pressure which is to be admitted to the brake-cylinder from the auxiliary reservoir, when making a graduating application of the brakes, the valve 29 has an independent movement relatively to the valve 14.

From what I have just said, I think it will be apparent that the function of *actually* opening the communication between the auxiliary reservoir and the brake-cylinder, in making a graduating application of the brakes, is not performed by the valve 29 instead of the valve 14, in the mechanism shown in the patent in suit. Or, in other words, that the valve 29, alone, cannot perform the
358 function of actually opening such communication, and that it requires not only the movement of the valve 29, but also of the valve 14, in order that such communication shall be open, and, taken as a whole, neither one of these valves 14 and 29 can, alone, open communication between the auxiliary reservoir and the brake-cylinder, in making a graduating application of the brakes, and the movement of both valves is required.

Of course, when the valve 14 has once been moved into position to make a graduating application of the brakes, communication between the auxiliary reservoir and the brake-cylinder can be again opened and closed by the movement of the valve 29 alone, if it is desired that a second, third, or fourth admission of auxiliary reservoir pressure to the brake-cylinder be made, but it is to be remem-

bered that a graduating application of the brakes can be made without a second, third or fourth admission of auxiliary reservoir pressure to the brake-cylinder being made.

Notwithstanding the fact that a second, third, or fourth admission of auxiliary reservoir pressure to the brake-cylinder can be made without moving the valve 14, a graduating application of the brakes cannot be made without the movement of the valve 14 taking place, as described by me.

288 X Q. Still assuming the bushing 9 to be removed from the Boyden apparatus, and said apparatus, therefore, to be capable of use only for making a service-stop or graduating application of the brakes, do you regard its valve 22, and the stem containing the port 40, in said Boyden apparatus, as being the mechanical equivalent of the valve 14 and graduating valve 29, in the apparatus of the patent in suit, so far as concerns the function of admitting auxiliary reservoir air to the brake-cylinder, and closing such admission, in the application of the service stop or a graduation?

A. I understand the part of said defendants' apparatus to which counsel has applied the term "port 40," to be the portion of
359 the main valve 17–18 of plate XI of defendants' 1891 catalogue, which was marked by me in my former deposition as *i*, *k*, *j*, and which consists of the port *i*, passage *k*, and port *j* in the said main valve. It will depend somewhat upon the connection in which the words "mechanical equivalent" are to be used, whether I would consider the valve 22, and the portion of the main valve containing the ports *i*, *j* and the passage *k*, of said defendants' mechanism, the mechanical equivalent of the valve 14 and graduating valve 29, of the mechanism shown in the patent in suit.

In the broad sense in which the term "mechanical equivalent" is sometimes used, I should consider the valve 22 and the main valve 17–18, as the mechanical equivalent of the slide-valve 14 and valve 29. For instance, if I were considering the question of the combination of a plain triple valve with another mechanism, and the result to be attained by that combination did not depend upon the differences in construction or operation of the parts which made up the plain triple-valve portion of the combination, then, in such a case, I should consider the two as mechanical equivalents, or, as I think would be more correctly stated, that one would be a substitute for the other, in such a combination as indicated above.

As I understand said defendants' quick-action triple valves, and as I have seen the same tested, I do not regard the valve 22, and what counsel has termed "the stem containing the port 40," as the mechanical equivalent of the valve 14 and graduating valve 29, of the mechanism shown in the patent in suit, when making a service-stop or graduating application of the brakes.

So far as concerns the use of said defendants' quick-action triple valves, for making graduating and service stop applications of the brakes, the valve 22 might as well be a permanent part of the mechanism and wholly incapable of movement, while this is not the case with the valve 14 of the mechanism shown in the patent

in suit. Therefore, the valve 22, as a valve, has no function
360 whatever to perform in said defendants' quick-action triple valves, in making a graduating or service-stop application of the brakes and would not be, strictly speaking, the mechanical equivalent of any portion of the valve 14 and graduating valve 29, of the mechanism shown in the patent in suit.

Of course, the valve 22, as before stated, would, under the circumstances assumed in the question, perform the function of closing communication between the auxiliary reservoir and the brake-cylinder, except through the usual connections required when making a graduating or service-stop application of the brakes, but this function I do not refer to, when saying "strictly speaking, the mechanical equivalent of any portion of the valve 14 and graduating valve 29, of the mechanism shown in the patent in suit."

289 X Q. In the apparatus of the Westinghouse patent in suit, for the purpose of making service stops or graduating applications of the brakes, why was it necessary for Mr. Westinghouse to construct the apparatus so that not only the valve 29, but also the valve 14, should be moved to effect the admission of auxiliary reservoir air to the brake-cylinder? And why could he not effect such admission by constructing the apparatus so that a movement of valve 29 alone would open communication between the auxiliary reservoir and brake-cylinder.

A. The question assumes that it was necessary that the mechanism shown in the patent in suit be made in a particular way. So far as the question inquires about any such necessity, I must answer that I know nothing about it. That is, I know of no necessity which would require that the mechanism should be made in one way or another, so far as the graduating or service-stop application of the brakes is concerned. As I understand the matter, "the apparatus of the Westinghouse patent in suit" may be of any construction that the constructor sees fit to make it, in respect to the portion of such apparatus which has specially to do with the functions
361 of a plain triple valve, that is, the functions required in making graduating and service-stop applications of the brakes.

The only reason that appears to my mind why the mechanism shown in the patent in suit is constructed so that not only the valve 29, but also the valve 14, should be moved to effect the admission of auxiliary reservoir air to the brake-cylinder, is, that Mr. Westinghouse found it convenient to illustrate the invention of the patent in suit, in connection with a well-known form of plain triple valve, wherein the valve 14 and graduating valve 29 were both required to be moved, when making a graduating or service-stop application of the brakes.

290 X Q. Very well, I refer to that "well-known form" in my interrogatory, and I ask why it was necessary, in that form of plain triple valve, that not only the valve 29, but also the valve 14, should be moved to effect the admission of auxiliary reservoir air to the brake-cylinder, in the act of making a service-stop or a graduating application of the brakes?

A. The previous question simply referred to the patent in suit in these words: "In the apparatus of the Westinghouse patent in suit," &c., and made no reference specifically to the well-known form of plain triple valve known prior to the date of the invention of the quick-action automatic system of brakes by Mr. Westinghouse. The patent in suit particularly provides for the use of any kind of plain triple valve, no matter what its specific construction may be, in the combinations particularly recited in the claims thereof, so far as concerns the plain triple-valve functions, and I answered the question with that understanding.

The present question appears to be confined to only one of the several kinds of plain triple valves known at the date of invention of Mr. Westinghouse in the patent in suit. I must say that I do not know of any necessity which required Mr. Westinghouse, at the date of his application for the patent illustrating the construction referred to in the present question, to make the graduat-
362 ing valve 29, and also the valve 14, both move, when making
a graduating application to effect the admission of auxiliary reservoir pressure to the brake-cylinder. Mr. Westinghouse might have illustrated his invention set forth in the patent which illustrates the well-known form of triple valve referred to in the question, otherwise than he did do, that is, he might have illustrated it with a different form of valve than the one shown in that patent. He found it convenient to illustrate that invention in connection with the particular kind of valve there shown, and, furthermore, this particular form of valve was one used by him in automatic systems of brakes, as I understand the matter.

This particular form of valve required to be moved, to close communication between the brake-cylinder and the atmosphere, as well as to be moved to open communication between such cylinder and the atmosphere. Furthermore, as this particular form of valve then existed, the triple-valve piston had a movement relatively to the valve, and it was a very convenient construction to adopt, in connection with the illustration of the invention found in such prior patent. The above are the only reasons, that I know of, why Mr. Westinghouse, in said prior patent, used the construction there shown, unless it be, that in addition to the above, the slide-valve with its so-called lost motion, was also an invention of his.

291 X Q. I did not ask why Mr. Westinghouse selected the form of plain triple valve which contained the graduating valve 29 and the slide-valve 14, as shown in his patent No. 360,070. He selected it, and, having selected it, he retained that feature of it which consists in its requiring a movement not only of the graduating valve 29, but of the main valve 14, in order to effect the admission of air from the auxiliary reservoir to the brake-cylinder, in the act of making a service-stop or a graduated application of the brakes. I assume that he would have simplified the valve arrangement
363 by dispensing with the necessity of moving the slide-valve
14 for such purpose, unless there was some necessity for its being so moved; and I ask you what such necessity was. Please

answer this question, if you know what the necessity was, without digressing into other matters.

A. I desire to state that I am not aware of digressing into other matters as stated in the question. The fact is, the questions are so indefinite that they may mean one thing or another, and therefore, I have to make explanations, and answer them, under the different meanings which they are capable of having put upon them.

The assumption of the present question seems to me unwarranted, when all the facts are considered.

As counsel now explains his question, it would seem to be substantially this. Mr. Westinghouse having adopted, for the purposes of illustrating the invention of the patent in suit, a triple valve proper, or plain triple valve, in which the main valve was of the sliding type, and which opened and closed communication between the brake-cylinder and the atmosphere, and also was provided with a graduating valve, which required that such graduating valve and main slide-valve both should have a movement, in order to effect the admission of air from the auxiliary reservoir to the brake-cylinder, in the act of making a service-stop or a graduating application of the brakes, what was the necessity for this requirement of the devices so selected. It would seem to me that after Mr. Westinghouse had once made the selection of devices having the above requirements that the necessity of the requirements was wholly due to the selection. At least, that is the only necessity that I can see for the requirement.

I must admit that the question to me is an exceedingly blind one, and that I cannot say I fully understand it, and if I have not stated what the question is intended to ask, I shall have to request counsel to make his meaning more clear.

364 292 X Q. You certainly have not answered my question, and, as you say you do not understand it, I will put it in other words.

In his patent No. 360,070, Mr. Westinghouse showed the triple valve proper of his prior patent No. 220,556. In that triple valve proper, there is a graduating valve seating in a slide-valve, and both must be moved in order to effect the admission of air from the auxiliary reservoir to the brake-cylinder, in making a service-stop or graduating application. There was evidently some reason for both of those valves being required to move for that purpose, or in that act; and I desire to know what the reason was.

A. I believe that I have answered the question fully, regarding the triple valve proper, or the plain triple valve, used to illustrate the invention of patent No. 220,556, but have no objection whatever to again answering it, but this seems to be an entirely different question from the one which preceded it, and which it purports to be the substance of.

Answering the question as to the specific construction of plain triple valves shown in patent 220,556, which construction differs somewhat from the construction shown in the patent in suit, I would say that the only reason of importance why the graduating valve, termed in said patent "auxiliary valve e^1", is made to move with

the main valve, designated in said patent as H, when making a service-stop or graduating application of the brakes, is that both are arranged to be moved by the triple-valve piston, and that they both have to be moved, in order to close and open communication between the brake-cylinder and the atmosphere.

Or, in other words, the slide-valve H has to be moved by the triple-valve piston, in order to open and close communication between the brake-cylinder and the atmosphere, and the connection of the so-called graduating or auxiliary valve e^1, to the triple-valve piston, necessarily requires that such auxiliary valve e^1, and slide-valve H, be moved, in order that a service-stop or graduating application of the brakes be made.

365 293 X Q. And the fact that the slide-valve 14 is charged with the function of opening and closing communication between the brake-cylinder and the atmosphere, is the thing that renders it necessary to give that slide-valve a movement, before admitting the auxiliary reservoir air to the brake-cylinder, to effect a service-stop or a graduated application of the brakes; is it not?

A. It is. Of course I refer to the specific form of valve shown in the patent in suit and designated as 14.

294 X Q. In the defendants' apparatus, as illustrated by plates IX (catalogue of 1889) and XI (catalogue of 1891), the valve 22 (15) is not charged with the function of opening and closing communication between the brake-cylinder and the atmosphere, is it?

A. The valve 22 (15) of said defendants' quick-action triple valves is not charged with any of the functions of a triple valve proper, including, of course, the function of opening and closing communication between the brake-cylinder and the atmosphere. Of course, I refer to the valve 22 (15) as a valve in this answer.

295 X Q. Question repeated, and the witness is requested to give a categorical answer to the question, without forcing in matters which might be a proper answer to some other question, but are not responsive to this one.

A. It is not.

296 X Q. Now, assuming the bushing 9, of defendants' said valve mechanisms, to be removed, and said mechanisms therefore to be capable of use only for service stops and graduation, state whether or not, for such service-stop and graduation purposes, the valve 22, the valve consisting of the stem which contains the port 40, and the valve 17 which controls communication between the brake-cylinder and the atmosphere, are, collectively, the mechanical equivalent of the main valve 14 and graduating valve 29, of the Westinghouse patent in suit?

366 A. The present question differs only from X Q. 288, in that it puts into the question, in terms, the portion of the main valve 17–18, designated 17 by me, in my former deposition, which I had to assume in my answer was present in that question, in order that a service-stop or graduating application of the brakes be made as stated in said X Q. 288.

My answer to the present question would be in substance the same as my answer to X Q. 288 was, which, briefly stated, is, in

substance, that under one understanding of the term "mechanical equivalent," that is, in certain combinations where substitute devices which, strictly speaking, are not the mechanical equivalent of the device of the combination, may be used, and yet serve the general purposes of the combination, the valve 22 and main valve 17–18 may be said to be, collectively, the mechanical equivalent of the valve 14, and graduating valve 29, of the mechanism shown in the Westinghouse patent in suit.

Under another understanding of the term "mechanical equivalent," that is, where each part must serve substantially the same function, in substantially the same way, the valve 22, and main valve 17–18, of said defendants' quick-action triple valves, would not be the mechanical equivalent, when taken collectively, for the valve 14 and graduating valve 29, of the mechanism shown in the Westinghouse patent in suit, because the valve 22, of said defendants' quick-action triple valve, does not find its functional equivalent in the valve 14 and graduating valve 29, of the mechanism shown in the patent in suit. That is, the valve 22, of said defendants' quick-action triple valves, does not, as a valve, serve any function whatever, in performing a graduating or service-stop application of the brakes, and at the most, can only be said that it serves the function of a permanent part of the mechanism at such time, and not the function of a valve which is required to be moved, when making a graduating or service-stop application of the brakes.

297 X Q. In defendants' said apparatus, the valve 17 is the
367 mechanical equivalent of the valve 14 of the patent in suit, so far as concerns the opening and closing of communication between the brake-cylinder and the atmosphere; is it not?

A. It is. I believe I pointed out this fact in my former deposition.

298 X Q. The fact that the communication between the brake-cylinder and the atmosphere is opened and closed by the separate valve 17, in the defendants' apparatus, and is not controlled by valve 22, renders it unnecessary that the latter valve, 22, should be given any movement in effecting the admission of auxiliary reservoir air to the brake-cylinder in making a service-stop or graduation application; does it not? I mean, renders it unnecessary that there should be any provision or means for enabling the valve 22 to control the communication between the brake-cylinder and the atmosphere, by making a movement for that purpose.

A. The fact that the communication between the brake-cylinder and the atmosphere is opened and closed by the separate valve 17, in defendants' quick-action triple valves, has nothing whatever to do, as I understand the matter, with rendering it unnecessary that the valve 22 should be given movement when effecting the admission of auxiliary reservoir pressure to the brake-cylinder, in making a service-stop or graduating application of the brakes.

The real reason why it is not necessary to give movement to the valve 22, of said defendants' quick-action valves, when making a graduating or service-stop application of the brakes, is that such valve, as a valve, has no function to perform at such time or times.

Of course, it might be said, in a general way, that because the valve 22 has nothing whatever to do, as a valve, with the opening and closing of communication between the brake-cylinder and the atmosphere, that therefore it need not be moved or be provided with means for moving it, but this will be as true of any other part which had nothing to do with the making of a graduating or service-stop application of the brakes, as it is of the valve 22.

368 To illustrate my meaning I would say, that it being the fact that this desk, at which we are at work, has nothing to do with the making of a graduating or service-stop application of the brakes by defendants' quick-action triple valves, therefore it would not be necessary that the desk should be moved, or any provision be made for the moving of the same, when making a graduating or service-stop application of the brakes.

299 X Q. If a separate valve were not provided for the purpose of controlling the communication between the brake-cylinder and the atmosphere in the defendants' apparatus, the valve 22 would have to be provided with means for controlling that communication, or else the apparatus would be totally inoperative and useless, would it not?

A. No, it would not, as I understand the matter, but, on the contrary, would be as effective as it is now and, because of the fact that the valve 22, as a valve, has nothing whatever to do with performing the function of a triple valve proper, in said defendants' quick-action triple valves. So far as I am concerned, I must admit that I have used the term "separate valve," in connection with the opening and closing of communication between the brake-cylinder and the atmosphere, in said defendants' quick-action triple valves, somewhat loosely, for, strictly speaking, it is not true of the mechanism shown in plate XI of defendants' 1891 catalogue, any more than it would be true of the mechanism shown in the patent in suit.

In the mechanism illustrated in plate XI of defendants' 1891 catalogue, the part therein designated as 17, is as much a part of the portion designated as 18 therein, as are the corresponding parts of the valve 14, of the mechanism shown in the patent in suit. That is, in each case, they are connected together as one piece, so as to partake of each and every movement given to either one of them, and, in each case, they are provided with different ports or
369 passages which they control, so that their functions are the same.

300 X Q. In defendants' apparatus, if the valve 17 were not separate from the valve 22, the latter would have to be provided with means for controlling the communication between the brake-cylinder and the atmosphere, and given a movement for that purpose, or else the apparatus would be totally inoperative and useless, would it not?

A. I should expect that if any attempt was made to provide the valve 22, of said defendants' quick-action triple valves, with means for controlling communication between the brake-cylinder and the atmosphere, that said quick-action triple valves would be totally

inoperative and useless for the purposes of a triple valve proper, and therefore, I do not see how the fact that the portion of the main valve designated 17, and which closes communication between the brake-cylinder and the atmosphere, being separate from the valve 22, has anything to do with providing the valve 22 with means for opening and closing communication between the brake-cylinder and the atmosphere.

If the valve above designated as 17, in said defendants' quick-action triple valves, was attached to the valve 22, so that when one moved the other moved, then, of course, some other means would have to be provided for opening and closing communication between the brake-cylinder and the atmosphere, but I do not conceive of any means, at this time, which could be employed for this purpose, and have such means connected to the valve 22, so that a movement of the latter would be required to operate the former.

301 X Q. Of course, in the supposed case, it would be necessary to change the *form* of valve 22 and of its port. But suppose it was changed to the form of the slide-valve, for example, the form substantially as shown in the Westinghouse patent No. 220,556; then, in that case, it would be necessary to give the slide-valve a movement to enable it to close and open communication between
370 the brake-cylinder and the atmosphere, besides providing a graduating valve, to effect the admission of auxiliary reservoir air into the brake-cylinder, in making a service stop or a graduation. Am I right?

A. I cannot say whether you are or not, for the simple reason that the question does not give me any definite idea of the mechanism counsel has in mind.

If counsel will provide drawings and a description of his assumed structure, so that I may know just what it is, I shall then be pleased to attempt to make answer to the question; until then I cannot, for the reason given.

302 X Q. I will leave this subject for the present, to recur to it at a future time; and I will now proceed to other inquiries.

In the defendants' apparatus, the restricted passage and the bushing 9 are arranged between the piston chamber and the valve chamber, whereas, in the apparatus of the patent in suit, there is no restricted passage, or partition, or part of a partition, between the piston chamber and valve chamber; am I correct in this?

A. No, I do not think you are.

Adjourned to Tuesday, December 5, 1893, at 10.30 a. m.

New York, *December* 5, 1893—10.30 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of Henry F. Newbury resumed:

303 X Q. Why am I not?

A. The reason why you are not correct, in my opinion, is the way you state the matter. If you had said the restricted passage, and

the bushing 9 forming a part of the partition, were arranged between the piston chamber and the valve chamber, whereas,
371 in the mechanism shown in the patent in suit, the restricted passage was not arranged between the piston chamber and valve chamber, but that the piston chamber on the auxiliary reservoir side of the same was in open communication with the valve chamber, I should have said that you were correct. The restricted port I have reference to here, of course, is the restricted port which restricts or retards the flow of auxiliary reservoir pressure to the brake cylinder, at the time when the auxiliary reservoir and main air or train pipe pressure are to unite, when making a quick-action or emergency application of the brakes.

304 X Q. What substantial difference is there between my statements of the facts in X Q. 302 and your statement of them in your answer to X Q. 303?

A. The difference lies in the breadth of the statement, mine being a more limited one, and in strict accordance with the facts. Your statement might be understood this way, or it might be understood differently, and naturally I should expect it to be understood in such a way that it would be too broad to be in strict accordance with the facts.

There is a restricted passage between the piston chamber and the valve chamber, in said mechanism shown in the patent in suit, and there is a partition between the said piston chamber and valve chamber, in that mechanism, this partition being the piston itself and the restricted port, being the feeding-in port designated 51.

305 X Q. Do you really think that my X Q. 302 is capable of being construed to cover the triple-valve piston as a partition, and the feeding-in port 51 as a restricted passage, such as contemplated in my question?

A. I not only think it is capable of being so construed, but I also think it would be the ordinary construction put upon the question. A careful reading of the question shows that the wording of it is such that there is no direct reference made in the latter part
372 of the question to the first part of it, and taking the question as a whole, I think it would be the natural understanding of it, to take it just as it says. It will be observed that, in reference to the defendants' quick-action triple valves, the question is limited to "the restricted passage and bushing 9," while, when referring to the mechanism shown in the patent in suit, the words "there is no restricted passage, or partition, or part of a partition," are used. From this it will be seen that the words were apparently used in their broadest sense, in the latter part of the question, and without any qualifying expression whatever as I should naturally expect to find, if it had been the intent of the person asking the question to have it given the limited construction which it would require to have, in order to be in strict accordance with the facts.

306 X Q. X Q. 302 inquired whether, in the apparatus of the patent in suit, there is a restricted passage, or partition, or part

of a partition, *between* the piston chamber and valve chamber. You say this might be construed as including the piston 12 and feeding-in passage 51. But the piston 12 and feeding-in passage 51 are *within* the piston chamber, and are not between the piston chamber and the valve chamber. Hence, I ask you again on what ground you would construe my X Q. 302 as including the piston and feeding-in passage, in view of the explicit terms used?

A. If counsel is familiar with the mechanism shown in the patent in suit, I think he will have to admit that the triple-valve piston 12 shuts off the piston chamber from the valve chamber when it is in the position shown in figure 2 of the drawings of the patent in suit, and that the only communication between the piston chamber and valve chamber is by the feeding-in port which includes the small recess made in the triple-valve piston. He must also be aware of the fact that the triple-valve piston is in open communication with the main air or train pipe, as much as such chamber is in open communication with the auxiliary reservoir.
373 Therefore, there has to be a partition between the triple-valve piston chamber and the valve chamber, unless some other meaning is to be given to the terms than I know of; for, without such a partition and restricted passage, the mechanism would be wholly inoperative. It is because of these facts that I have made the preceding answers in the forms in which they appear.

307 X Q. Did you really understand my X Q. 302 as in any way relating to the piston 12 and feeding-in passage 51?

A. I understood the question as I have heretofore stated, and gave it what I thought would be the natural understanding of it.

I can only know what the question means by what is placed upon the record, and if counsel desires to make his questions definite, why he can do so, but I cannot tell what understanding he has of the question in his mind, when he does not make such understanding clear on the record.

I answered each and every question as fully and fairly as I can, including X Q. 302.

I make this statement in view of the implied unwillingness or unfairness in the statement of this and preceding questions. In fact, the present question implies that I understood the question differently from what I have stated, and such is not the fact.

308 X Q. In making a quick action with the mechanism described and shown in the Westinghouse patent in suit, does not the air which enters the brake-cylinder from the auxiliary reservoir, pass through a port controlled by one valve, and does not the air which enters the brake-cylinder from the train-pipe pass through another and different port controlled by another and different valve?

A. It does, as I have time and again stated, when the mechanism shown in the patent in suit is employed.

309 X Q. In making a quick action by the defendants'
374 mechanism illustrated in plate IX (1889 catalogue) and plate XI (1891 catalogue), do not the air which enters the brake-cylinder from the auxiliary reservoir and the air which enters the

brake-cylinder from the train-pipe, both pass through one and the same port, controlled by one and the same valve?

A. If the question is limited to the time when the valve 22 opens its port, I should answer that they do pass through one port to enter the brake-cylinder, as I have time and again heretofore stated.

The auxiliary reservoir pressure passes through a port which is restricted as to its capacity, so that the flow of auxiliary reservoir pressure to the brake-cylinder is restricted or retarded, and none of the pressure from the main air or train pipe passing to the brake-cylinder, when making a quick-action or emergency application of the brakes, passes through this restricted port or passage. The fact is, that the auxiliary reservoir pressure, in both forms of defendants' quick-action triple valves, must necessarily pass through a port, through which main air or train pipe pressure cannot pass, when a quick-action or emergency application of the brakes is to be made, with either one of said defendants' quick-action triple valves.

The fact is, that the auxiliary reservoir and main air or train pipe pressures have united, and lost their individualities as main air or train pipe and auxiliary reservoir pressures, at the time they pass through the port or opening controlled by the valve 22, in said defendants' quick-action triple valves, and, at such time, it is wholly immaterial whether they pass through one opening alone to reach the brake-cylinder, or two ports, passages, or openings, as is evident from the fact that, in one form of said defendants' quick-action triple valves, namely, the one illustrated in plate XI of defendants' 1891 catalogue, these united pressures pass through a single port, opening, or passage to reach the brake-cylinder, while in the other form of said defendants' quick-action triple valve, the one shown in plate IX of defendants' 1889 catalogue, these united pressures
375 have to pass through two ports, openings, or passages, after passing the valve 22, before the brake-cylinder is reached. As I understand the matter, it is wholly immaterial how many ports or passages the auxiliary reservoir and main air or train pipe pressures pass through, after they have united to enter the brake-cylinder, but it is material and essential that the auxiliary reservoir pressure shall pass through a port or passage which restricts its flow, and through which main air or train pipe pressure cannot pass, and also that the two pressures, before they unite to pass into the brake-cylinder, must pass through two different ports or passages, in order that a quick-action or emergency application of the brakes can be made.

All that part of the above answer from and after the words "As I have time and again heretofore stated," is objected to by defendants' counsel, as a volunteered argument irresponsive to the question.

310 X Q. During the making of a quick action, with the mechanism described and shown in the Westinghouse patent in suit, does not the air which enters the brake-cylinder from the auxiliary reservoir, pass through the port or passage 35–22, controlled by the valve 14, while the air which enters the brake-cylinder from the

rain-pipe, passes through the port 42 controlled by the valve 41; and during the making of a quick action, with the defendants' nechanism shown in said plates IX and XI, do not the air which enters the brake-cylinder from the auxiliary reservoir, and the air which enters the brake-cylinder from the train-pipe, both pass through the one port controlled by valve 22? Please answer this question responsively, without argument, and without discussing other matters that are not inquired of.

A. I shall endeavor to answer the question responsively,
376 but, nevertheless, I am under obligations to answer it truthfully; therefore, I must say that, as independent pressures, the auxiliary reservoir and main air or train pipe pressures do not pass through the port controlled by valve 22, in defendants' quick-action triple valves.

In the mechanism shown in the patent in suit, the auxiliary reservoir pressure, as an independent pressure, passes through the port or passage 35–22, 23, which port or passage is controlled or brought into register by the slide-valve 14, while the air from the main air or train pipe, as an independent pressure, passes through the port 42, chamber 43, and passage 46, to enter the brake-cylinder, the same as I have heretofore described.

311 X Q. In my last cross-question, 310, I said nothing about "independent" or non-independent pressures, but simply asked about the *air* which entered the brake-cylinder from the auxiliary reservoir and train-pipe, respectively; calling your attention to this fact, I repeat said interrogatory, and request you to give a direct and responsive answer to it, without attempting to force into it qualifications or limitations which do not exist in the question?

A. I desire to answer the question truthfully, and in fact must answer it that way or not at all, and, therefore, must state the facts as they exist and not by my answer misrepresent them. This I did in my preceding answer, and such answer, so far as I can see, is thoroughly responsive to the question. What counsel seems to term forcing into the question "qualifications or limitations which do not exist in the question" is nothing more, as I understand it, than simply stating the facts as they exist.

If he uses terms in the same question in one sense, in connection with one mechanism, and in another sense in connection with another mechanism, and without stating that he uses the same terms in a different sense, I cannot adopt the same terms,
377 when they mean different things, in connection with two pieces of mechanism.

The fact is, that after the auxiliary reservoir, and main air or train pipe, pressures have united to enter the brake-cylinder, at that time it is nothing more or less than brake-cylinder pressure, and not auxiliary reservoir and main air or train pipe pressures, although, of course, the brake-cylinder pressure is made up of main air or train pipe and auxiliary reservoir pressure.

We use the terms, main air or train pipe pressure, auxiliary reservoir pressure, and brake-cylinder pressure, simply to designate the same pressure in different parts of the apparatus.

From this it will be seen that, as a matter of fact, the two pressures, one from the auxiliary reservoir and the other from the main air or train pipe, after they have united to enter the brake-cylinder, are no longer correctly termed auxiliary reservoir and main air or train pipe pressures, and to insist upon so terming them is misleading and not in strict accordance with the facts.

It was because of the above that I answered X Q. 310 as I did, and I do not see how it could be truthfully answered any other way. With the above explanation, I will refer counsel to my above answer as an answer to the present question.

312 X Q. In X Q. 310 I said nothing about *pressure*, but spoke only of *air*. You have twice insisted upon placing a qualification upon my question, and then answering it as thus qualified by you. I now repeat the question again, and ask you to give a direct and responsive answer to it, without first attempting to qualify it, or alter its meaning.

A. I will have to ask counsel to state what he means by "air," as he seems to have used the term differently from what is understood in the air-brake art, as I understand the use of such term in such art.

313 X Q. As you do not understand what I mean by the word "air," I will endeavor to explain what I mean by it. I mean
378 that physical substance, of a gaseous form, composed of a mixture of oxygen and nitrogen, which substance moves from the auxiliary reservoir to the brake-cylinder, and also moves from the train-pipe to the brake-cylinder, in both the apparatus of the patent in suit and the apparatus of plates IX and XI of defendants' catalogues, in the act of making a quick application of the brakes. And in X Q. 310 I meant to ask you whether, in the making of a quick action, with the mechanism described and shown in the Westinghouse patent in suit, so much of that substance as enters the brake-cylinder, from the auxiliary reservoir, passes through the port or passage 35–22, controlled by the valve 14, while so much of that substance as enters the brake-cylinder, from the train-pipe, passes through the port 42 controlled by the valve 41; also whether, during the making of a quick action with the defendants' mechanism shown in plates IX and XI, do not so much of that substance as enters the brake-cylinder, from the auxiliary reservoir, and so much of that substance as enters the brake-cylinder, from the train-pipe, both pass through the one port controlled by the valve 22? If you now understand my question, please reply to it responsively and directly.

A. I do not fully understand now just what counsel means by "air" as he has explained it, as he has said nothing about the pressures of his air at the various times, by reason of which the several mechanisms are made to work, and, as I understand the term "air," as used in the fluid-pressure automatic brake mechanism, it is air under compression, and the terms "pressure" and "air," at the different times, are used as synonymous, meaning one and the same thing, and I believe this is the general understanding

f these terms, used in connection with the fluid-pressure brake iechanism.

It seems that counsel uses the term "air" in a different sense rom what it is generally understood.

It would seem that my answer to X Q. 309 was a complete
79 answer to the question, even in the sense in which counsel seems to have used the term "air," but it seems, for some eason, he has seen fit to pursue the inquiry, and, if his explanation ieans anything, it seems to me it must mean precisely what I stated ; might mean, and, under that meaning, I fully answered the uestion in my answer to X Q. 309. It is true, as I there stated, hat at the time when the valve 22 opens its port, the air from the uxiliary reservoir and the main air or train pipe, passes through hat one port to enter the brake-cylinder, and this is the fact, and if hat is the fact that counsel wants to elicit, I answered it then and gain answer it now.

Likewise, at the time that the slide-valve 14 opens the port or pasage 35–22, 23, so much of the "air" or "pressure" as enters the rake-cylinder from the auxiliary reservoir, passes through such ort or passage, and at the same time, so much of the air or pressure vhich enters the brake-cylinder from the main air or train pipe, asses through the port or passage 42, 43 and 46, controlled by he valve 41, in the mechanism shown in the patent in suit, and hese facts I have never disputed, and have heretofore pointed them ut both in my former deposition and in the present one.

I make this explanation in view of the statements contained in his and preceding question, which imply that I do not fairly answer he question.

314 X Q. In the Westinghouse patent in suit, the passage 42, 43, 16, 47, 48, is the passage through which the train-pipe air is conlucted to the brake-cylinder, in the act of making a quick-action pplication of the brakes. The passage 22 leads from the valve hamber 24 into the chamber 47, forming a portion of the passage 12, 43, 46, 47, 48, and thereby enables the auxiliary reservoir air, fter it leaves the valve chamber, to unite with air coming from the rain-pipe through said passage 42, 43, 46, 47, 48, in the act of making a quick application of the brakes. Was there any reason why he passage 22 should thus lead into the other passage, and why the passage 22 should not be connected to the brake-cylinder by
380 a passage entirely separate from the passage 42, 43, 46, 47, 48, except in the matter of having, from the chamber 47 to he brake-cylinder, a single passage, instead of two separate pasages? In other words, except for mere purposes of simplicity of construction, might not the air from the auxiliary reservoir have een delivered to the brake-cylinder, by a passage entirely separate rom the passage which delivers the train-pipe air to the brakecylinder, in making a quick application of the brakes, and would not such construction have answered every requirement of the Westinghouse invention in suit?

A. As I understand the question, it is substantially this: Is it essential or material to the invention of the Westinghouse patent

POOR COPY

in suit, whether the main air or train pipe pressure and auxiliary reservoir pressure, actually unite before entering the brake cylinder or not, so long as the respective pressures pass through properly proportioned ports or passages, so that they may unite in such cylinder, as set forth in the patent in suit.

With this understanding of the question, I should answer that I do not understand it to be material or essential, so far as the invention of the Westinghouse patent in suit is concerned, whether such two pressures actually unite before entering the brake-cylinder or after they have actually entered what would be technically known as the brake-cylinder. That is, whether they actually enter such cylinder through two passages or one. The essential thing, as I understand it, is that they should unite in the brake-cylinder, in properly regulated quantities.

315 X Q. If the valve 41 was removed from the apparatus of the patent in suit, and the port 42 plugged, what would be the effect on the action of said apparatus?

A. There would be no admission of main air or train pipe pressure directly to the brake-cylinder of the mechanism of the patent in suit, and this would be the case upon simply plugging the
381 port 42, and without the removal of the valve 41, as such
plugging would render the valve 41 useless for any purpose that I call to mind at this time.

316 X Q. With said valve 41 removed and port 42 plugged, would the apparatus still operate as a plain triple valve?

A. Yes, it could be made to so operate.

317 X Q. Would it, without any further change in it, so operate?

A. Yes, it could be made to so operate without any change whatever.

318 X Q. What do you mean by your expression "could be made" to so operate?

A. I mean it could be made to so operate upon the proper manipulation of the engineers' valve or cock, and when the proper connections are made between the mechanism thus changed, and the main reservoir from which the fluid pressure is obtained.

319 X Q. The removal of the valve 41 and the plugging of the port 42, then, would have the same effect upon the action of the apparatus of the patent in suit, as the removal of the bushing 9 would have upon the action of the apparatus used by defendants and illustrated in plates IX and XI of their 1889 and 1891 catalogues, respectively; will it not?

A. There would be the same general effect produced in each case, that is, the prevention of a quick-action or emergency application of the brakes.

320 X Q. And without preventing the use of the two mechanisms, respectively, for the purposes of making service stops and graduating applications of the brakes; is that true?

A. Yes, that would be included within the said general result.

321 X Q. Would such removal of the valve 41 and plugging of the port 42 remove any portion of the "partition," which, in your 248 X A., you say you find in the quick-action triple valve shown

in the patent in suit, and which, in your 249 X A. you say "consists of the metal which divides the auxiliary reservoir, valve
382 chamber 24, and triple-valve piston chamber 11, on the one hand, and the brake-cylinder upon the other, including, of course, the metal composing the slide-valve 14, with its restricted port or passage 35"?

A. As I understand the partition and its restricted port, in the mechanism shown in the patent in suit, the plugging of the port 42 and the removal of the valve 41 would not necessarily remove any portion of such partition.

322 X Q. Assume the apparatus shown in the patent in suit to have the valve 41 removed and the port 42 plugged, and to be used on a train, with the necessary connections, main reservoir, engineers' valve, train-pipe, auxiliary reservoir, brake-cylinder, etc., as used in actual practice; and assume that by accident the train-pipe became ruptured or broken in two so as to suddenly reduce the pressure therein, and apply the brakes automatically; and please describe the movement of the triple valve, and of the air passing through it that would then occur in such automatic application of the brakes? In other words, tell us just how the apparatus would act in making such automatic application?

A. Upon the rupture of the main air or train pipe and the sudden reduction of pressure therein, the triple-valve piston would be forced backward as far as it could move, and, at the beginning of this backward movement, the valve 29 would become unseated, and then the valve 14 would be moved in the direction of the movement of the triple-valve piston, until the port 31 was in register with the port 23, 22, and the port 33 was brought out of register with ports 23 and 34, thus shutting off communication between the brake-cylinder and the atmosphere, and opening communication between the auxiliary reservoir and the brake-cylinder. The communication between the auxiliary reservoir and the brake-cylinder, through the port 31, 23, is momentary, owing to the fact that the valve 14 and triple-valve piston would continue their move-
383 ment to the limit of the backward movement of such piston. At this time, the port 35 would be in register with the port 23, so that communication between the auxiliary reservoir and the brake-cylinder would be open, and this communication would remain open, until the pressures in the brake-cylinder and auxiliary reservoir became substantially equalized, or the same as to extent.

Such a rupture of the main air or train pipe would allow of all the pressure therein to escape and consequently the brakes would be held on, by the equalized pressure of the auxiliary reservoir and brake-cylinder, until such time as they should be released, either by leakage, the removal of pressure from the brake-cylinder and the auxiliary reservoir, or the mending of the rupture and again establishing the main air or train pipe pressure.

323 X Q. Assume the same apparatus and the same conditions stated in my last question, with the further condition that the passage 35 were plugged; and state just how the apparatus would.

act upon the sudden reduction of pressure in the ruptured train-pipe, and what would result?

A. The movements of the parts would be identically the same, under the assumption of the present question, as they were under the assumption of the preceding one, but, owing to the fact that the port 35 was plugged or, in other words, did not exist, then of course, the brakes would only be applied with the force which entered the brake-cylinder at the time that the port 31 momentarily registered with the port 23, upon the backward movement of the triple-valve piston, and, therefore, the pressure in the auxiliary reservoir and brake-cylinder would not be substantially equal, or of the same extent, under the assumptions of the question, as would be the case under the assumptions of the previous question.

324 X Q. Assuming the same apparatus and all the conditions stated in X Q. 323, and assume that the auxiliary reservoir pressure were standing at its normal seventy pounds at the time when such rupture of the train-pipe occurred; and tell me, as
384 nearly as you can estimate, how much air pressure would be established in the brake-cylinder, by the air which flowed into it during the momentary passage of port 31 over port 23, as you have stated?

A. I cannot state how much pressure there would be in the brake-cylinder at the time stated, for the simple reason that there are so many things which enter into the problem, that it would be almost impossible to make an estimate, and I never have made any experiments which would demonstrate the amount of pressure which would ordinarily exist under the conditions named.

325 X Q. The amount of pressure so established in the brake-cylinder would be very small, would it not?

A. I should expect that it would be.

326 X Q. Do you think that it would be as much as five pounds to the square inch in the brake-cylinder?

A. That I cannot say, but I am under the impression that it would be less than five pounds, although this is merely a wild guess, without any reliable data to base the opinion upon.

327 X Q. As the Westinghouse air brakes are constructed and used, how much air pressure is required in the brake-cylinder to overcome the resistance of the spring against the piston of the brake-cylinder and move said piston?

A. I never have examined as to this point when making tests and, therefore, cannot say what the necessary pressure is to overcome the springs which are used to force the brake-shoes away from the wheels.

328 X Q. The spring that is used to force the brake-shoes away from the wheels is the spring marked 53, in figure 7 of the patent in suit, is it not?

A. Yes.

329 X Q. Assume the apparatus used by the defendants, and shown in plates IX and XI of their 1889 and 1891 catalogues, respectively, but with the bushing 9 removed; assume such apparatus to be used on a train with all the necessary connections referred to

in X Q. 322; then assume that by accident the train-pipe
385 became ruptured or broken in two, so as to suddenly reduce the pressure therein and apply the brakes automatically; and please tell us just how the apparatus would act in making such automatic application.

A. The rupture of the main air or train pipe and sudden reduction of pressure therein, would cause the triple-valve piston to move backward, and, as it moved backward, the portion of the main valve designated by me as 17, would close communication between the brake-cylinder and the atmosphere, and then the other portion of the main valve, containing ports *i, j* and passage *k*, would be moved sufficiently to open communication between the auxiliary reservoir and the brake-cylinder momentarily, while the triple-valve piston was moving the main valve sufficiently for the collar *m*, of the mechanism illustrated in plate XI of defendants' 1891 catalogue, to come in contact with the auxiliary valve 22, and move such valve so as to open communication between the auxiliary reservoir and the brake-cylinder to a much greater extent than when such communication was through the main valve alone, which would cause the pressure in the auxiliary reservoir to almost instantly equalize with the pressure in the brake-cylinder and thus apply the brakes automatically. The equalization of the pressures in the auxiliary reservoir and the brake-cylinder occurs almost instantly, owing to the large opening made between the two by the movement of the auxiliary valve 22, when the triple-valve piston moves to the extent of its backward movement.

A rupture of the main air or train pipe which would suddenly reduce the pressure therein, would permit of the entire escape of the main air or train pipe pressure, and consequently, the brakes would be held on by the equalized pressures in the brake-cylinder and auxiliary reservoir, until the pressure in the brake-cylinder was released by leakage, opening communication between the auxiliary reservoir and the atmosphere, or the mending of the rupture
386 in the main air or train pipe, and re-establishing main air or train pipe pressure therein.

330 X Q. The apparatus of the patent in suit, under the conditions assumed in X Q. 322, and the defendants' apparatus, under the conditions assumed in X Q. 329, would act substantially the same, except that the equalization of pressure between the auxiliary reservoir and the brake-cylinder would take place more quickly in the defendants' apparatus than in the apparatus of the patent in suit; am I not *b*orrect?

A. You are substantially correct.

331 X Q. If, instead of the form of triple valve shown in the patent in suit, the form of triple valve shown in the Westinghouse patent No. 220,556 were substituted, then, under the conditions stated in X Q. 322, the Westinghouse apparatus would act substantially the same as the defendants' apparatus would act under the conditions stated in X Q. 329, except that the equalization of air pressure between the auxiliary reservoir and the brake-cylinder, in the Westinghouse apparatus, would take place more quickly

than when the triple valve used was constructed in the form shown in the patent in suit; am I not correct?

A. I hardly know what the question is intended to mean. As it appears to me, it simply asks what the action of the triple valve shown in patent 220,556 would be, when used in the ordinary manner, and upon an accident occurring which would rupture the main air or train pipe, and thereby suddenly reduce the pressure in such pipe. If the question is intended to ask any more than this I would like counsel to so state and explain the question further before proceeding to answer it.

332 X Q. You may answer the question upon the assumption stated in your last answer, as that will enable us to get at the facts referred to in my question.

A. The triple valve shown in patent 220,556, when used in the ordinary manner and upon the occurrence of an accident which would rupture the main air or train pipe and suddenly re-
387 duce the pressure therein, would act as follows: The sudden reduction of pressure in the main air or train pipe would cause the triple-valve piston to move backward, first unseating the valve designated as auxiliary valve e^1 in said patent, then moving the slide-valve H so as to close communication between the brake-cylinder and the atmosphere, then momentarily opening communication between the brake-cylinder and the auxiliary reservoir, through the port s^2 in the valve H, while such port is in register with the port C, leading to the brake-cylinder, and then closing such communication, and opening it again when the port s^1 of the valve H is in register with said port C. This last communication is also momentary and lasts while the port s^1 is in register with said port C. The continued movement of the triple-valve piston and the valve H, again opens communication between the auxiliary reservoir and the brake-cylinder, when the valve H has passed beyond or from over any portion of the said port C. This latter occurs when the triple-valve piston is at the extreme limit of its backward stroke, or nearly so, and it permits the auxiliary reservoir pressure to expand into the brake-cylinder and the two pressures to substantially equalize and thus apply the brakes.

A rupture of the main air or brake pipe which would thus suddenly reduce the pressure therein, would permit all of the main air or train pipe pressure to escape, and, consequently, the brakes would be held on by the equalized pressures in the auxiliary reservoir and brake-cylinder until such pressures were released by leakage, the removal therefrom by opening communication between the auxiliary reservoir and the atmosphere, or, upon the mending of the rupture in the main air or train pipe, and re-establishing main air or train pipe pressure therein.

333 X Q. The action of the Westinghouse apparatus of the patent in suit under the conditions stated in X Q. 322; the action of the defendants' apparatus under the conditions stated in X Q. 329; and the action of the apparatus of the Westinghouse patent
388 220,566 under the conditions stated in X Q's 331 and 332; would be substantially the same, except that, with the de-

fendants' apparatus, the equalization of pressure between the auxiliary reservoir and the brake-cylinder would take place quicker than with the apparatus of either of the two Westinghouse patents, and said equalization would take place quicker with the apparatus of patent 220,556 than with the apparatus of patent 360,070; am I correct in this?

A. The actions of the several mechanisms would differ in other respects than those stated by counsel, but, notwithstanding this, the general effect of simply applying the brakes automatically by an equalization of pressure in the auxiliary reservoir and brake-cylinders of the several mechanisms, would be substantially the same, except as to the particulars named in the question. That is, the same general result, namely, applying the brakes automatically by the equalized pressures of the auxiliary reservoirs and brake-cylinders, in the several mechanisms, is substantially the same, except as to the particulars named in the question.

334 X Q. The automatic application of the brakes, in case of the rupture of the train-pipe, is one of the important and advantageous features of the Westinghouse automatic air-brake system, so called; is it not?

A. It is.

335 X Q. When and in what patent did Mr. Westinghouse first introduce that important and valuable feature of air-brake mechanism.

A. I never have looked up the state of the art to determine in just what patent that feature appeared, but I believe it appeared in a Westinghouse patent which was issued early in the year 1872. It is a good while since I have read over the early Westinghouse patents, therefore I cannot at this time state which one was the first to show it.

336 X Q. It appeared in Westinghouse patent No. 168,369,
389 dated October 5, 1875, and had already at that time been made known in some prior patent of Mr. Westinghouse—am I not correct?

A I believe that you are.

Adjourned to Wednesday, December 6, 1893, at 10.30 a. m.

NEW YORK, *December* 6, 1893—10.30 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of HENRY F. NEWBURY resumed:

337 X Q. In your answer to X Q. 210, you speak of certain tests made by you, and I judge from the passages commencing with the words "by actual tests" and "furthermore I have made repeated tests" that you made at least two series or sets of tests with different mechanisms, both of which series are referred to in that answer; am I correct about that?

A. Yes, there are two series of tests, and with different quick-action triple valves referred to in that answer.

338 X Q. Please describe the tests first mentioned in that answer, stating the circumstances under which they took place, who was present, and where they took place.

A. I described the construction of the quick-action triple valve used in that test, in my answer referred to in the previous question, and also the results. The circumstances under which the said tests were made are substantially these. I desired to inform myself as to the action of quick-action triple valves, in some respects like those shown in plate XI of defendants' 1891 catalogue, so I requested the Westinghouse Air Brake Company to reproduce, as near as they could do, a quick-action triple valve like that shown in plate
390 XI of defendants' 1891 catalogue, except that there should not be a valve 22, and that there should be substituted in place thereof a permanent partition, as described by me, and that, if it was possible, such reproduction should be from a quick-action triple valve of defendants' construction which they had.

Some time afterward, I was informed by counsel in the case, that the quick-action triple valve had been reproduced, and was ready for test whenever the time could be arranged. A time was arranged for such test, and I visited Pittsburgh, where I met Mr. Bell, of counsel herein, and we went to the factory of the Westinghouse Air Brake Company, at Wilmerding, Pennsylvania, where the test took place. Mr. Bell, of counsel, was present and I believe a Mr. Welsh, superintendent of the works, with some of the workmen, were also present.

I cannot say positively at this time, but I am under the impression that Mr. H. H. Westinghouse was also present at these tests.

I am not positive on this point, owing to the fact that first and last, in connection with various matters, I have made quite a large number of tests, at some of which Mr. Westinghouse was present, and others where he was absent, and I do not recall, at this moment, any particular circumstance which would enable me to state that he was present at these particular tests.

339 X Q. Describe exactly the conditions under which those tests referred to in your last answer were made—I mean the conditions as to the connections, the engineers' valve, and whether the tests were made with a single triple valve alone, or whether they were made in connection with other triple valves?

A. I cannot at this time give the exact conditions under which the tests took place, but I will describe them as nearly as is possible at this time.

The tests were made on the testing bench used by the Westinghouse Air Brake Company to make tests of triple valves, and represented, as nearly as possible, the conditions present upon
391 trains and regular service. That is, there was a regular main reservoir, which was supplied with pressure from an air pump, a regular engineers' valve, and a main air or train pipe, connecting the main reservoir and engineers' valve with the triple valves, having the dimensions and length usual in actual use. Some of the tests were made with the single quick-action triple valve which the Westinghouse Company had reproduced, as before described, and

other tests were made with such single triple valve coupled, up in the usual manner, with a quick-action triple valve the same as plate XI of defendants' 1891 catalogue, a new Westinghouse quick-action triple valve, and a plain triple valve, representing the equipment of four cars and a locomotive, of course, excluding the tender.

In each case there was a brake-cylinder and an auxiliary reservoir, the pistons of the brake-cylinders not being actually connected to anything which would represent the connections between brake-shoes and such pistons.

Each auxiliary reservoir, brake-cylinder, and main air or brake pipe was provided with a pressure gauge, to register the pressures present in each of such cylinders, auxiliary reservoirs, and the main air or brake pipe. The pressure gauges attached to the main air or brake pipe were placed in the immediate vicinity of the main air or train pipe side of the triple-valve piston. In addition to the above pressure gauges, there was placed on each of the quick-action triple valves representing the mechanism of plate XI of defendants' 1891 catalogue, a pressure gauge, in connection with the valve chamber of each of those mechanisms, so that the pressure in such valve chamber could also be ascertained at different periods of time.

Tests were also made with the quick-action triple valve having a permanent partition substituted for the valve 22, when the regular defendants' quick-action triple valve was cut out, so that there were only three triple valves connected up. Tests were also made when another reproduction of the quick-action triple valve illus-
392 trated in plate XI of defendants' 1891 catalogue was substituted for the regular defendants' quick-action triple valve.

Tests were made for graduating, service-stop, and quick-action or emergency applications of the brakes. Tests were also made by manipulating the engineers' valve in different ways, when making graduating and service-stop applications of the brakes.

340 X Q. In your last answer you say that "tests were also made when another reproduction of the quick-action triple valve illustrated in plate XI of defendants' 1891 catalogue was substituted for the regular defendants' quick-action triple valve;" do you mean that the other reproduction was in any way different from the regular defendants' quick-action triple valve?

A. It was intended to be the same, but we desired to make tests in different ways which would require some mutilation of the casing of the triple valve, so that we could not use the regular defendants' quick-action triple valve, because it was desired to use that as an exhibit in this case.

341 X Q. By "the regular defendants' quick-action triple valve" do you mean the one in which the fixed partition had been substituted for the valve 22?

A. No; I do not, as I think will be apparent from my former answers.

342 X Q. Now, will you please describe all the particulars and conditions of the second series of tests mentioned in your answer

to Q. 210, commencing at the words "furthermore I have mad repeated tests"?

A. The second series of tests referred to were also made at th factory of the Westinghouse Air Brake Company, and there was only a single quick-action triple valve used in those tests, the constructio of which I substantially described in my direct examination. Thi quick-action triple valve was, as I understand the matter, of defend ants' manufacture, and, as before stated, was provided with glas windows in the valve chamber, so that the operation of the valv 22 could be readily observed.

393 These tests were made under various conditions, using th same main reservoir, but using different piping from tha here-fore described. Some of the tests were made with the length o pipe leading to and from the triple valve of substantially the lengtl used in actual service, and, at other times, varying the length o pipe to see if it made any difference; also some of these tests wer made with an engineers' valve or cock so arranged that we coul have different-sized openings for the escape of main air or trai pipe pressure, when reducing the pressure in the main air or brak pipe to operate the triple-valve piston.

These tests were made at my solicitation, so that I might furthe study the operation of defendants' quick-action triple valve, an see whether the conclusions I arrived at prior to the last-name test would be confirmed or not, as well as to see whether my under standing of the theory of the operation of said defendants' quick action triple valve under varying conditions were correct or not.

Other tests than those referred to in Q. 210 were made with thi quick-action triple valve provided with the glass window, as befor described.

At this second series of tests, Mr. Bell, of counsel herein, Mr H. H. Westinghouse, and some of the employees of the Westing house Air Brake Company were present.

343 X Q. In your answer to Q. 219 you refer to several series o tests; will you please describe all the conditions and particulars o those different tests?

A. I have already done so. The tests referred to in my answe to Q. 219 are tests which refer to the operation of defendants' quick action triple valve, when coupled up with the new Westing house quick-action triple valve, which tests I have this mornin described.

344 X Q. In your answer to Q. 232, and elsewhere in your deposi tion, you refer to the "principle or mode of operation" of the pat ented device of the patent in suit and of the defendants' device please state exactly the meaning that you attach to that ex

394 pression, "principle or mode of operation," and the sense in which you have used the term in your deposition.

A. I have used the term "principle or mode of operation" as referring to the law of operation of such mechanisms, or rather, the underlying principles upon which those mechanisms work, so far as quick-action or emergency applications of the brakes are con cerned.

345 X Q. Please illustrate your meaning by stating, as briefly as you can, the "principle or mode of operation," or the "law of operation," of the quick-action triple-valve device or mechanism of patent No. 360,070, in the sense in which you use those expressions.

A. The patent in suit, No. 360,070, describes a combination of devices by means of which three classes of work, as before described by me, are rendered capable of being performed by such combination or combinations of devices or elements. The patent in suit describes the construction and arrangement of these several elements or devices which go to make up the combination or combinations set forth in said patent, and states the results accomplished by such combination or combinations, and gives the necessary instructions for the construction of the elements or devices, and combining them together to perform such results.

These several elements or devices depend upon certain conditions being present, in order that they perform their respective parts in such combination or combinations. The patent in suit describes the mode of operation, and the action, of each of the respective devices or elements which go to make up the combination or combinations set forth in said patent.

The operation of the combination or combinations set forth in the patent in suit, as therein described, depends upon well-known principles or laws, governing the action of gaseous fluids when under compression, which laws or principles of action are well known. I refer here more especially to the actions of such fluids, when under compression, upon movable parts, which such fluids are to move by varying the degrees of compressions of the fluids at different times, as well as the passage of such fluids, when under compression, through ports or passages from one point to another, and the actions of such ports or passages have upon the degrees of compression of such fluids, after their passage through such ports or passages.

The principle or mode of operation of the mechanism set forth in the patent in suit, so far as concerns a quick-action or emergency application of the brakes, is as follows: Upon a sudden and material reduction of main air or train pipe pressure (say 15 to 20 pounds), the triple-valve piston will be moved backward to a further extent than ordinarily is the case, which backward movement opens an auxiliary valve, controlling a passage of considerable size, leading from the main air or train pipe to the brake-cylinder, and, at the same time, opens another passage, of comparatively small diameter, leading from the auxiliary reservoir to the brake-cylinder, both passages being open to the brake-cylinder at a time when such cylinder is comparatively free from pressure, so that the amount of compressed air or fluid pressure which can pass through each of the two passages in a given length of time is regulated or governed, to such an extent that the lower main air or train pipe pressure, (say 50 to 55 or more pounds), is permitted to enter the brake-cylinder in large volume, while the higher auxiliary reservoir pressure, (say about 70 pounds), is also passing into the brake-cylinder in small volume, the two pressures uniting at a point within the brake-cyl-

inder, which is in wide-open communication therewith, and brake-cylinder pressure is formed by such uniting of the main air or train pipe and auxiliary-reservoir pressure. The brake-cylinder pressure thus formed, is the pressure which acts upon the brake-cylinder piston to apply the brakes, and, when making a quick-action or emergency application of the brakes, is of a considerably higher pressure than when an application of the brakes is made by the equalization of pressure between the auxiliary reservoir and
396 brake-cylinder alone, and, under the above assumed conditions as to the amount of pressures, such united brake-cylinder pressure would be about 60 pounds, when the proportions of the several parts of the mechanisms are substantially the same as those in actual use.

Briefly stated, some of the essential requisites of the principle or mode of operation of the mechanism shown in the patent in suit are, when a quick-action or emergency application of the brakes is to be made, that the brake-cylinder shall be substantially free from pressure, that the point at which the main air or train pipe and auxiliary-reservoir pressures unite shall be in substantially wide-open communication with the brake-cylinder, that the passage leading from the main air or train pipe to the brake-cylinder, and controlled by the auxiliary valve, shall be of considerable size, and that the passage or port between the auxiliary reservoir and the brake-cylinder, at this time, shall be of comparatively small diameter, so that the flow of auxiliary-reservoir pressure to the brake-cylinder at this time is restricted, retarded, or small in quantity.

346 X Q. In the ordinary application of the Westinghouse quick-action air brake for an emergency stop, how much higher pressure is obtained in the brake-cylinder than with the action of the plain triple valve?—assuming, in both cases, that the application is made with full force, so that the pressure in the brake-cylinder becomes equalized with the pressure in the auxiliary reservoir?

A. As before stated, the brake-cylinder pressure, when making a quick-action or emergency application, with the Westinghouse quick-action triple valve, is about 60 pounds, when main air or train pipe pressure before the sudden reduction is 70 pounds, while, with the same apparatus, in making a service-stop application, the brake-cylinder pressure is about 50 pounds, with a train-pipe pressure at 70 pounds, as before stated.

This is also the case with the Westinghouse plain triple valve, if I remember correctly, although, at this time, I cannot give
397 the exact figures obtained at the tests heretofore described, as they took place some considerable time since.

Of course, in each case, this is when the pressures in the auxiliary reservoir and brake-cylinders have equalized, and applied the brakes with the full force possible.

347 X Q. How many valve-controlled ports, passages, or channels, for the traverse of air under pressure from the auxiliary reservoir to the brake-cylinder, were actually used in a valvular appliance known prior to 1887, in operating it as a triple valve?

A. That would depend wholly upon what particular valvular appliance is used.

348 X Q. Assume that the valvular appliance described and shown in the Westinghouse patent No. 220,556 was used, and answer the question.

A. I should say that, in the plain triple valve shown in patent 220,556, there were three valve-controlled ports, passages, or channels for the traverse of air under pressure from the auxiliary reservoir to the brake-cylinder.

349 X Q. What three?

A. The two in the slide-valve H designated as s^1, s^2, and the third by the uncovering of the passage C by the movement of the valve H either partly or wholly beyond such passage.

350 X Q. In that apparatus, the passage s^2 is simply for leakage purposes, is it not?

A. The port or passage s^2 is, I believe, primarily provided for removing pressure from the auxiliary reservoir by leakage, but, nevertheless, as I understand it, pressure does not enter the brake-cylinder through such port or passage in the application of the brakes, but, as before explained, this can only be to a limited extent, owing to the momentary time that the said passage is in register with the port C.

I also believe that some pressure might leave the auxiliary reservoir through this port, at this time, which did not enter the
398 brake-cylinder, but, notwithstanding this fact, I also understand that auxiliary reservoir pressure at this time also enters the brake-cylinder.

351 X Q. The amount of auxiliary reservoir pressure entering the brake-cylinder during the passage of the port s^2 over the port C would be practically inappreciable, would it not?

A. That would depend upon circumstances. The port s^2, in the operation of the brakes, might admit almost as much pressure to the brake-cylinder as the port s^1 admits.

This would depend wholly upon circumstances contingent upon the operation of the mechanism.

352 X Q. What circumstances?

A. For instance, the extent of reduction of main air or train pipe pressure; also, the extent of friction of the slide-valve H, as well as the friction of other parts of the mechanism, when making a graduating application of the brakes.

353 X Q. In the ordinary application of the brakes for a service or graduation, with the apparatus shown in patent 220,556, would not the amount of pressure admitted from the auxiliary reservoir to the brake-cylinder, through the port s^2, be practically inappreciable?

A. I do not see but what it might be practically inappreciable, or practically appreciable, according to circumstances beyond the control of the person making what he supposes to be an ordinary graduating application of the brakes.

To further explain my meaning, assuming a train of cars, four or five in number, fitted with plain triple valves like those illustrated

in patent 220,556, and the engineer desirous of making a graduating application of the brakes to hold his train in check, he would make a small reduction of pressure in his main air or train pipe, and if, in one or more of the triple valves, there was more friction of the slide-valve than in the other, the reduction in pressure would not move the slide-valve H as far, in such valve or valves, as it would in the other, from which it would result that, in the
399 case of the slide-valve having the greatest friction, the port s^2 would be left in register with the port C, and also at the same time a portion of the port s^1 would be in register with the same port C, while, with the triple valves provided with slide-valve H having less friction, such valves H would be moved a trifle farther, so as to move the port s^2 out of register with the port or passage C, so that practically all of the pressure entering the brake-cylinder, through the last-named valve, would pass through the port s^1, which would not be the case with the triple valve or valves in which the slide-valve H had the most friction. The difference in the movement of the slide-valves in the two cases is only slight, and the result, as to the amount of pressure entering the brake-cylinder from the auxiliary reservoir, would be the same whether it all passed through the port s^1, or part of it through that port, and the rest through port s^2, the only difference being that, when the pressure passed wholly through the one port, it would enter the brake-cylinder a trifle quicker than would be the case when such pressure passed partly through one and partly through the other.

254 X Q. Do you understand that it was the intention of Mr. Westinghouse, the patentee, to utilize the port s^2 for transmitting auxiliary reservoir pressure to the brake-cylinder, in the act of making a service stop or a graduating application of the brakes?

A. I have already stated what I understood was primarily the purpose of the port or passage s^2, and such understanding I obtain from the specification of patent 220,556.

If we can judge of the intentions of Mr Westinghouse by the mechanism which he produced, I should say that it was his intention, under the circumstances stated by me, to have that mechanism operate as I have stated, for I cannot for a moment think that he did not fully know what the operation of the mechanism would be, under varying conditions.

What we have been pleased to term service-stop applica-
400 tions of the brakes, can be performed in different ways, by the mechanism shown in the patent 220,556; therefore, as to that branch of the question which couples service-stop application of the brakes with graduating application, I should answer that by the same reasoning, with service-stop applications of the brakes by the mechanism of patent 220,556, it was the intention of Mr. Westinghouse that they be made at some times without any appreciable pressure passing from the auxiliary reservoir to the brake-cylinder through the port or passage s^2, and that only a very small, and probably an inappreciable, amount, would pass through this port, although possibly, when making a service-stop application by simply

continuing a graduating application, more than this inappreciable amount might pass through such port s^2.

My reason for this is, that I should expect, with the length of train heretofore assumed, and when a graduating application is continued long enough, there would be a sufficient reduction of main air or train pipe pressure to overcome the difference in friction and move the slide-valves H sufficiently far, so that the port s^2 of no one of them would be in register with the port or passage C, although, in doing this, some of the slide-valves might be moved far enough to move the slide-valve H of some of the triple valves sufficiently far for such valve to partially uncover the port or passage C to a small extent, and thus permit part of the pressure from the auxiliary reservoir to pass through the port s^1, and part of it through the uncovered portion of the port or passage C, when making a service-stop application of the brakes, with such plain triple valves.

355 X Q. You state that "what we have been pleased to term service-stop applications of the brakes can be performed in different ways by the mechanism shown in patent 220,556;" describe the several different ways in which such service-stop applications can be performed by said mechanism, including in your description a statement as to how the several parts move, and how the

401 several ports functionate during said different ways?

A. Service-stop applications of the brakes, as explained by me in my former deposition herein, and as I understand the term has been used herein, are applications of the brakes where the same are applied with the full force of auxiliary reservoir pressure, although possibly, in some instances, such is not the case. But even taking the term as meaning the admission, to the brake-cylinder, of auxiliary reservoir pressure sufficient to bring the train to a stop, I think it is manifest that service-stop applications of the brakes can be made in different ways by the mechanism shown in patent 220,556. Of course, we must bear in mind the fact, testified to by Mr. Church, one of defendants' experts, that the amount of fluid pressure which would be simply a graduating application of the brakes, may become, under other circumstances, a service-stop application. I mention this fact simply to show that possibly the term service-stop applications of the brakes, has not always been used with the understanding stated above. The different applications of the brakes, with plain triple valves like those shown in patent 220,556, are performed by the difference in extent of the reduction of main air or train pipe pressure by the engineer, and consist in the bringing of the valve H in different positions relatively to the port C. I have already described at length, the operations of this mechanism, and I will simply add that a service-stop application can be made with plain triple valves like those shown in patent 220,556, when the triple-valve pistons and slide-valves H, of those triple valves, are moved backward to the extent of their movement in that direction, as, for instance, if it was desired to stop the train on a considerable down grade, I should expect that it would be necessary to reduce the pressure in the main air or train pipe so that the triple-valve pistons would be moved backward to the extent of

POOR COPY

their movement in that direction, and that the stopping of
402 the train would be nothing more than what would be termed
a service stop. That is, the train would be stopped without inconvenience to the passengers. The same reduction of main air or train pipe pressure used for making a service stop, on a considerable down grade might, on a considerable up grade, stop the cars too suddenly, and thus cause inconvenience to the passengers.

From the above, it will be seen that the conditions under which the brakes are applied vary so widely that it is wholly dependent upon the discretion of the engineer, just how, in each particular instance, he will apply the brakes, to accomplish the result he desires, and that there is no cast-iron rule by means of which he shall manipulate the engineer's valve or cock, and give a certain extent of movement to the parts of a triple valve, and because of this, the extent of movement of such parts will vary when making a service-stop application of the brakes, with triple valves like those shown in patent 220,556.

356 X Q. In making a service stop on a considerable down grade, why would the engineer reduce the pressure in the main air or train pipe, so that the triple-valve pistons would be moved backward to the extent of their movement in that direction, in using the brake apparatus described and shown in patent No. 220,556?

A. I have not attempted to give the reasons why an engineer would do one thing or another. The former question asked me as to different ways in which service-stop applications of the brakes can be made with the triple valve shown in patent 220,556, and I made answer to that question stating that a service-stop application could be made in the way described.

I suppose the engineer in this case, as in all others, would make a service-stop application, in whichever way it is made, because he wanted to do it that way, and could manipulate the apparatus at hand to so accomplish such result.

357 X Q. You stated more than that. You stated that
403 under the circumstances indicated in my last question you
"should expect that it would be necessary to reduce the pressure in the main air or train pipe so that the triple-valve pistons would be moved backward to the extent of their movement in that direction." I want to know why you should expect that it would be necessary to reduce the pressure in the train-pipe so that the triple-valve pistons would be moved backward to the extent in their movement of that direction.

A. I should expect that he would want to apply his brakes under these circumstances with their full force, and that there should be no mistake about it even if some of the slide-valves had a greater amount of friction than he had reason to expect them to have, and also knowing that, by so doing, he would insure the full force at his command, and without interfering with the comfort of the passengers.

At the moment of answering the preceding question I overlooked the fact called to my attention in the present question, or it had for the moment escaped my mind.

358 X Q. Is it not also true that by reducing the pressure in the main air or train pipe, so that the triple-valve pistons would be moved backward to the extent of their movement in that direction, the brakes would be applied with their full pressure in a shorter time than they could be applied by bringing into use simply the port s^1 of patent 220,556?

A. Considering each triple valve alone, yes.

359 X Q. And is that not one of the reasons why the engineer, under the circumstances stated in your answer to X Q. 355 and in X Q. 356, might be expected to reduce the pressure in the train-pipe so that the triple-valve pistons would be moved backward to the extent of their movement in that direction?

A. No, I should not expect that it would. It is a well-known fact that, owing to dust or grit entering triple-valve mechanisms, the pistons themselves, or some part connected with them, at times fail to respond to the ordinary reductions of pressure which are calculated to move them, and I should expect that this would
404 be the main reason, and practically the only reason, so far as the sudden reduction of the main air or train pipe pressure is concerned, why the engineer would make such sudden reduction, and thus insure the full application of the brakes upon each and every car of the train, he knowing that a sudden reduction of main air or train pipe pressure would cause a piston, which might, under other circumstances, stick, to surely be moved backward, and apply the brakes upon that car, instead of failing to do so. Of course, he would take into consideration, under the circumstances named, that even with the brakes applied as quickly as possible with that mechanism, there would be no inconvenience to the passengers, and he would naturally want to obtain the full application of the brakes upon each and every car, and would make this sudden reduction, so that there would be no mistake or failure to obtain such full application of the brakes.

360 X Q. In thus reducing the pressure suddenly, so as to cause the triple-valve pistons to move backward to the extent of their movement in that direction, the valves H would pass from the ports C and open said ports wide open, would they not?

A. That will depend on just what is meant by the words "the valves H would move past the ports C." I find, from an examination of the drawings, that there is a difference in the movement of the valve H respectively to the port C in figures 1 and 4 of patent 220,556.

It is true that the valves H would uncover the ports C to the extent that they are capable of uncovering them. To this extent, my answer would be that they would.

361 X Q. And when the port C was thus uncovered to the extent that the valve H was capable of uncovering it, auxiliary reservoir air would flow to the brake-cylinder more quickly than it could flow through the port s^1, and would apply the brakes with their full force in a shorter time than they could be applied
405 with their force, by air passing through the port s^1; is this the fact?

A. This question is in substance identical with X Q. 358, and I shall have to answer it the same way, viz., considering each triple valve alone, yes.

363 X Q. In the Westinghouse patent 220,556, how does the cross-sectional area of the port C compare in size with the cross-sectional area of the port s^1?

A. I shall have to make some calculations in order to answer this question, but I call attention to the fact that there is a variation in different figures showing these parts, so that there is nothing definite that can be said upon the subject.

365 X Q. Please make the necessary measurements and calculations to enable you to answer my question tomorrow morning.

Adjourned to Thursday, December 7, 1893, at 10.30 a. m.

NEW YORK, *December* 7, 1893—10.30 a. m.

Met pursuant to adjournment.

Present: Counsel as before.

Cross-examination of HENRY F. NEWBURY resumed:

A. to 363 X Q. Before answering the question, I desire to say that upon further measuring the movement of the parts in figures 1 and 4 of the drawings of patent 220,556, I find that I was in error yesterday, and that the slide-valve H in both of those figures moves past the port C, so as to fully uncover such port or passage. I cannot say how this error occurred, but I am satisfied that it did occur, and desire that it be corrected, so far as possible.

I find the diameter of the port s^1 to be $\frac{12}{100}$ of an inch, which gives a cross-sectional area for such port .01130976 of a square inch.

406 I find that the port or passage C, of figure 1, has a diameter of $\frac{21}{100}$ of an inch, which gives a cross-sectional area of such port or passage of .03463614 of a square inch. The same port or passage C, in figure 3, I find to be $\frac{22}{100}$ of an inch in diameter, which gives a cross-sectional area of such port or passage of .03801336. The same port or passage C, in figure 4, I find is $\frac{19}{100}$ of an inch in diameter, which gives a cross-sectional area of such port or passage of .02834294.

From this it will be seen that the port s^1 is of the same cross-sectional area, while the cross-sectional area of the ports or passages C vary as above set forth.

In figure 1, the cross-sectional areas of the port s^1 and the port or passage C are .01130975 and .03463614 respectively. In figure 3, the same ports or passages compare as .01130976 is to .03801336. In figure 4, the same ports or passages compare as .01130976 is to .02834294.

I find that the passage connecting with the port s^1, varies in size in the different figures, while the port s^1 is the same, therefore the capacity of the port s^1, in the different figures, also varies as the cross-sectional area of the passage leading to the port s^1 is less than that of the port itself.

364 X Q. How does the capacity of the passage leading to the port s^1 compare with the port itself?

A. The cross-sectional area of the port s^1, as above stated, is .01130976, in each of the several figures, and the cross-sectional area of the passage opening into the port s^1, in figure 1, is .00950334. In figure 3, the cross-sectional area of the same passage is .00636174. And in figure 4, the cross-sectional area of the same passage is .007854.

I cannot determine from the several figures whether the passage leading from the valve chamber through the slide-valve H, and transversely to the above-named passage into which port s^1
407 opens, its opened sufficiently to give the passage into which the ports s^1 opens its full capacity of transmitting fluid pressure to such port.

365 X Q. Referring to the Boyden patent No. 280,285, the "always-open one-way passage" is therein described as follows:

"Extending from the drip-chamber is a passage D, provided with a check-valve, *d*, adapted at all times to allow compressed air from the train-pipe P^2 to reach the air reservoir on the car, but preventing its return therefrom, whereby no loss of fluid pressure from reservoir R^3 can occur in case of accidental separation of the car from the train, and serving also, as hereinafter explained, to allow compressed air from the train-pipe to reach the brake-cylinder C^3 while the brake is applied. As the fluid pressure can take but one direction in this passage, I call it 'an always-open one-way passage.' A passage substantially like this, always open for fluid pressure to reach the air reservoir on the car, constitutes one feature of my invention."

In the defendants' quick-action triple valves illustrated in plate IX (1889 catalogue) and plate XI (1891 catalogue), is there not a similar "always-open one-way passage," to wit, a passage always open for fluid pressure to reach the air reservoir on the car from the main air or train pipe, and in which passage the fluid pressure can take but one direction?

Objected to as immaterial.

A. The Boyden patent shows wo forms of passages provided with a check-valve, which can be opened in one direction for the passage of air or fluid pressure from the main air or train pipe to the air reservoir, or, as heretofore termed, the auxiliary reservoir, upon the car. Applying the description above quoted generally to
408 such passage and check-valve as a feeding-in passage, defendants' quick-action triple valves do have such an always-open one-way passage, or feeding-in passage, for the admission of main air or train pipe pressure to the auxiliary reservoir.

366 X Q. In said Boyden patent No. 280,285, if the capacity of the port R were so restricted as only to be equal to about one-third or one-half of the capacity of the port or passage C^1, then, upon a sudden reduction of air pressure in the train-pipe, sufficient to move the valve H backward to the limit of its movement in that direction and thereby fully uncover the passage C^1, the exhaust of air pressure

from the chamber containing the valve H into the brake-cylinder through the passage C^1 would so reduce the air pressure in said chamber as to cause the train-pipe pressure to unseat the check-valve in the passage D, and admit train-pipe air directly from the train-pipe, through the passages D, R^1 and C^1, to the brake-cylinder, at the same time that auxiliary reservoir pressure would be flowing through the restricted port R and the passages R^1 and C^1, to the brake-cylinder; am I not correct?

A. I am not prepared to answer this question, for the simple reason that I cannot say at once whether restricting the port R to the extent stated would produce the result assumed or not, and would not feel justified in answering the question without full investigation and satisfying myself upon the actual operation of the whole mechanism when only the change suggested was made.

The mechanism of this Boyden patent is a complicated mechanism, and depends upon a great many circumstances for its operation, some of which are not present in any other mechanism that I know of. If I am given the actual mechanisms, with the necessary time and facilities to investigate the subject, I will then be pleased to answer the question, but until then I do not feel justified in attempting to do so, owing to the lack of sufficient data upon which to form an intelligent opinion.

409 367 X Q. Upon such data as you already have, can you not form any opinion on the subject of my last question?

A. No, not that I would feel justified as terming an opinion. I could make a wild guess, which would not be of any value whatever, and that is all.

I have learned enough about the operations of different mechanisms, operated by varying fluid pressure therein, to know that there are so many conditions which enter into the problem that when I thought I understood the operation of one of these kinds of mechanisms, under changed conditions, I found afterward that I had omitted to consider some fact essential to the matter, and therefore, I have thought it necessary to experiment with the changed mechanism, and prove the correctness of my opinions as to their operations, before feeling justified to state my conclusions concerning such structures, or at least to have experimented in the direct line of the changes, with mechanisms which confessedly operate in the same way.

368 X Q. With your present information, does your mind incline to answer X Q. 366 in the affirmative or in the negative?

A. My mind is in such a state that I cannot say one way or the other, and, upon actual test, should not be surprised in the least whether you would be found correct or incorrect in the assumption you have made in said X Q. 366.

369 X Q. If in said X Q. 366 I had assumed the capacity of the port R to be still further reduced, say, so as to be equal only to one-tenth of the capacity of the port or passage C^1, would it enable you to form an opinion on the subject of my question?

A. I even then should not care to express an opinion upon the matter, for the reason, as before stated, there are other matters

which enter into the problem, which are not present in any mechanism which I have ever seen operated or experimented with. I have no hesitation in saying that the port R and the other
410 passages, by means of which auxiliary reservoir pressure reaches the brake-cylinder, might be so proportioned, relatively one to the other, that the check-valve *d* would be unseated when the valve H fully uncovered the port or passage leading to the brake-cylinder. This, of course, also requires proportioning the strength of the spring holding the check-valve *d* seated. This is as far as I would care to go, without something more definite than I have now before me, regarding the apparatus of the said Boyden patent.

It will be remembered that there is nothing whatever in the Boyden patent relating to any such changed construction as has been suggested by counsel.

370 X Q. Would it require proportioning the spring any differently from what it is proportioned in said structure of the Boyden patent referred to?

A. It might, or it might not, as the proportioning of the spring in said Boyden structure is a very indefinite thing, and might be such as would require a different proportioning under the changed condition from what it is there.

To explain my meaning, I believe that a spring can be placed to hold the check-valve 26, of defendants' quick-action triple valves seated, so that the main air or train pipe pressure will not enter the brake-cylinder directly when one spring is used, where it would so enter when another spring was used, and, in both cases, the said quick-action triple valves would serve as triple valves proper or plain triple valves.

371 X Q. In your answer to Q. 234, you quote certain matter which at one time stood in the specification of the application of Mr. Westinghouse for patent No. 360,070, and which was canceled by the same communication that inserted in said specification the disclaimer quoted in Q. 234. You also state in said answer that you have, at all times, been of the understanding that a quick-action triple valve, in which the function of admitting main air or train pipe pressure directly from the main air or train pipe
411 to the brake-cylinder, was performed by a valve which was integral with the main valve, and formed by an extension thereof, would be included within the invention of the patent in suit, because it would embody the essential operative features of such invention.

In forming your opinion as to the scope of the claims sued upon, have you regarded the cancellation of those words which were originally embodied in Mr. Westinghouse's specification and were afterward cancelled as aforesaid, as amounting, in effect, to a disclaimer?

Objected to as being wholly a question of law and not therefore competent.

Defendants' counsel states that the witness has necessarily been

obliged to deal with the question of the scope of the claims in suit or, at least, to give his testimony upon some theory as to the scope of said claims, and the present question merely seeks to ascertain whether or not he has treated said cancellation as in any way limiting the scope of the terms used in the claims in suit.

Counsel for complainants replies that the witness' understanding of the scope of the claims in suit, so far as relates to the canceled subject-matter referred to, has been very clearly indicated by his testimony referred to in the question, and therefore, whether or not said canceled subject-matter amounts in law, and in effect, to a disclaimer, is altogether immaterial. If the court should so hold, it will of course reject the witness' testimony relating to the inclusion of such canceled subject-matter in his view as to the scope of the claims, and if not, it will probably accept it. Moreover, the question does not ask as to limitation of the scope of the claims by the cancellation of such matter, but asks, in terms, whether such cancellation amount in effect to "a disclaimer."

412 Defendants' counsel says that, of course, the court is the
sole judge of the legal question involved; but if the witness, in his direct examination, has seen fit, as complainants' counsel states, to indicate his understanding of the scope of the claims in suit so far as relates to the canceled subject-matter referred to, then it follows that defendants' counsel has a perfect right to cross-examine him upon the matter referred to, and it was with this view that defendants' counsel dictated the present interrogatory.

A. No, I have not, for, as I understand such matters, the simple cancellation, in a specification, of matter not in any way brought about by the prior state of the art, does not in any way affect the scope of the invention, and such cancellation does not, in any way, affect the natural and obvious understanding to be had of the claims. That is, such a cancellation of matter is simply the same as if it had never been put into the specification, or had never existed.

372 X Q. And it is with that understanding that you have given your testimony in this case, is it?

A. It is, as I before stated. I knew of such cancellation, and had it in mind before giving my former testimony, and had such in mind when I was cross-examined as to my understanding of the terms found in the specification and claims of the patent in suit in such former deposition.

373 X Q. In the case of George Westinghouse, Jr., and The Westinghouse Air Brake Company, *vs.* The New York Air Brake Company, Isaac B. Newcombe, Royal C. Vilas, Charles A. Starbuck, and John C. Thompson, directors, in equity, in the circuit court of the United States in and for the southern district of New York, and on the 16th day of December, 1891, as it appears by the printed record of the pleadings and complainants' proofs in that case, on
413 pages 143 and 144 thereof, you were asked the following
question and gave the following answer:

"96 X Q. Is it not now obvious to you that 360,070 is the pioneer patent for the automatic quick-action brake system, which consists

essentially of a train-pipe connected to the brake-cylinder by the usual service-stop passage, and also connected to the brake-cylinder by an emergency-stop passage.

"A. It is not now obvious to me that patent 360,070 is the pioneer in the sense that it contains claims broad enough, under any interpretation which I understand to be allowable, to cover all forms of quick-action automatic systems of brakes.

"The facts set forth in this cross-examination were not new to me when I gave my former deposition, and they produce no greater impression on my mind now than they did then.

"We have to take the patents as we find them, not as they might have been."

This is a correct copy of the said cross-question and your answer thereto, as printed in said record, is it not?

Objected to as irrelevant, immaterial and not proper cross-examination.

A. I believe that the language quoted in the question is correctly copied from the printed record of suit No. 4977, referred to in the question.

374 X Q. What patents were sued upon in that suit?

Same objection.

A. There were three patents set up in the bill, namely, Nos. 376,837, 168,359 and 172,064.

HENRY F. NEWBURY.

Adjourned to Monday, December 11, 1893, at 11.30 a. m.

414 NEW YORK, *December* 11, 1893—11.30 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

H. H. WESTINGHOUSE, being recalled, deposes and says, in answer to interrogatories propounded to him by J. Snowden Bell, Esq., of counsel for complainants, as follows, to wit:

375 Q. Are you the same H. H. Westinghouse who has heretofore testified in this cause?

A. I am.

376 Q. Have you read the depositions of defendants' witnesses, George A. Boyden and Joseph B. Church, in this cause?

A. I have.

377 Q. As a practical expert in the art of automatic air brakes for railroads, please state the distinguishing and essential characteristics of a "triple valve," as such appliance was used in said art prior to 1887, and with special reference to its several functions?

A. The distinguishing characteristics of the triple valves used prior to the time stated, was a construction of the mechanism that provided for passages or connections between a train-pipe and an auxiliary reservoir, between an auxiliary reservoir and brake-cylinder, and between the brake-cylinder and the atmosphere.

The distinguishing features of operation were that the passage leading from the train-pipe to the auxiliary reservoir should be open, when the passage leading from the auxiliary reservoir to the brake-cylinder was closed, and that the passage leading from the train-pipe to the auxiliary reservoir should be closed, when the passage leading from the auxiliary reservoir to the brake-cylinder was open. It was also necessary that the passage leading from the brake-cylinder to the atmosphere should be closed when the passage from the auxiliary reservoir to the brake-cylinder was open.
415 These are the essential characteristics of triple-valve construction and operation prior to 1887.

378 Q. So far as the means for admitting pressure from the auxiliary reservoir to the brake-cylinder are concerned, in triple valves as known prior to 1887, what was the only essential consideration, structurally, in that regard?

A. The only essential requirement was a port or passage, leading from the auxiliary reservoir to the brake-cylinder, that was opened, when the port leading from the train-pipe to the auxiliary reservoir was closed, and which was closed, when the port leading from the train-pipe to the brake-cylinder was open. In the art of manufacturing triple valves, there were detailed modifications in the valve arrangements which controlled the flow of air through the various ports and passages of the triple-valve structure, and these changes were made for the purpose of rendering the operation of the original form of triple-valve construction more satisfactory in its practical operation.

The most important of these modifications relates to capability of admitting less than the maximum air pressure from the auxiliary reservoir to the brake-cylinder, as this capability is the one that provides for the application of brakes with a graduated or maximum force as may be required.

This important function is obtained by a valve arrangement that permits of the opening and closing of the passage leading from the auxiliary reservoir to the brake-cylinder, without opening either the passage leading from the train-pipe to the auxiliary reservoir, or from the brake-cylinder to the atmosphere.

The improvement described is well illustrated in the triple valve shown in the patent No. 168,359 to George Westinghouse, Jr.

Patent No. 172,064 to George Westinghouse, Jr., shows a further improvement in triple-valve construction, in which some of the difficulties inherent in the use of a slide-valve, in triple-valve construction, are provided for. In the two constructions referred
416 to, there is but a single port or passage connecting the auxiliary reservoir with the brake-cylinder controlled by a single valve.

Patent No. 220,556 illustrates a further improvement in triple-valve construction, the object of the improvement being to increase the capability of the structure, in the direction of admitting limited amounts of air from the auxiliary reservoir to the brake-cylinder, when a maximum application of the brakes was not desired.

The triple valve in this patent has a single passage leading from

the auxiliary reservoir to the brake-cylinder, controlled by a valve, which valve may be operated to admit air from the auxiliary reservoir to the brake-cylinder with different degrees of rapidity, depending upon which portion of the valve controls the passage leading from the auxiliary reservoir to the brake-cylinder, and upon the manner in which the valve is operated.

The control of the passage leading from the auxiliary reservoir to the brake-cylinder, by more than one portion of the valve mechanism, is a mechanical convenience, in this structure, and is not an essential feature, or of any operative value. The effect produced by the double control of this port is equally well provided by a single control, when the parts are properly proportioned.

Patent No. 243,415 to George Westinghouse, Jr., illustrates a form of triple valve in which the passage leading from the auxiliary reservoir to the brake-cylinder is controlled by a valve having but a single capability of admitting air from the auxiliary reservoir to the brake-cylinder. This valve, so far as relates to the control of the passage leading from the auxiliary reservoir to the brake-cylinder, has all the practical advantages and capabilities of the valve shown in the patent 220,556, and was the latest form of triple valve, and the kind of which the largest number were in use prior to 1887.

379 Q. How many valve-controlled ports, passages, or
417 channels, for the traverse of air under pressure from the auxiliary reservoir to the brake-cylinder, were required in a valvular appliance known prior to 1887, in order to enable it to be fully and truly a "triple valve," and to perform all of the then known functions of such an appliance?

A. One.

380 Q. To what extent, if at all, would the addition of one or more passages for reservoir air to the brake-cylinder to the one which you say is necessary, bear upon the question of whether or not the valvular appliance was what was termed a "triple valve" prior to 1887?

A. It would have absolutely no bearing upon the question.

381 Q. In your answer to Q. 378, referring to patent 220,556, you say that the effect produced by the double control of the port leading from the auxiliary reservoir to the brake-cylinder is equally well provided by a single control, when properly proportioned.

Can you illustrate your meaning by giving an instance of such a proportioning of the parts in this patent as would provide the same effect, by a single control of the port, as is provided in the patent by the capability of a double control?

A. In the construction shown in patent 220,556, when communication between the auxiliary reservoir and the brake-cylinder is established, by bringing port s^1 to register with the port C, the flow of air from the auxiliary reservoir to the brake-cylinder will be less rapid than would be the case when port C is entirely uncovered by the complete movement of slide-valve H in a downward direction, for the reason that the port s^1 is of smaller diameter than port C, when port C is completely uncovered by slide-valve H.

If it were desirable, or mechanically convenient, to make port g^1 of the same size as port C, the same operative results would be obtained, with a single control of port C, that may, under some circumstances, be obtained by means of double control.

418 381½ Q. Are you familiar with the descriptive matter and representations of a quick-action triple valve contained in the specification and drawings of the Westinghouse patent No. 360,070 in suit? In answering this, and any other questions which I may put to you regarding this or any other patent, you may understand that you are not interrogated as to the *claims*, and need not refer to them.

A. I am.

382 Q. In his answer to Q. 6, in which he is asked to describe the construction and operation of the quick-action triple valve of the Westinghouse patent 360,070 in suit, defendants' witness G. A. Boyden makes the following statement, to wit:

"This is a valve mechanism used in automatic air brakes, the functions of which are: 1st. To admit air from the main air pipe to the auxiliary reservoir, through the valve port or feeding-in groove 51, shown in Fig. 2 of complainants' patent No. 360,070. 2d. To admit air from the auxiliary reservoir to the brake-cylinder through the port controlled by the graduating valve 29, by the preliminary movement of the piston 12. 3d. To admit auxiliary reservoir air to the brake-cylinder through the valve port 35 by the final movement of the piston. 4th. To exhaust air from the brake-cylinder to the atmosphere through the valve cavity 33. These four valves form what is commonly known as a 'triple valve' proper, as used in the art prior to 1887."

From your practical knowledge of the construction and operation of quick-action triple valves similar to that described and shown in patent 360,070, as well as your familiarity with the descriptive matter and drawings of said patent, state whether or not the statement of Mr. Boyden above quoted is true and correct in fact.

419 A. Mr. Boyden's statement with respect to the use of valve port 35 is incorrect. The presence of such port, or the functions performed by it, was no essential part of triple-valve construction prior to 1887.

383 Q. What, if any, function is performed by the valve port 35 of the quick action triple valve of patent 360,070, in any operation of said appliance in performing the function of a triple valve proper as used in the art prior to 1887?

A. None.

384 Q. Is it or not physically possible for the valve port 35 to perform any function whatever, in any operation of the appliance of patent 360,070 as a triple valve proper, as used in the art prior to 1887, and if not, why not?

A. No, for the reason that all of the functions of a triple valve proper are performed in the appliance of 360,070 without bringing the port 35 in a position to perform any function whatever. That

is to say, during the operations of the appliance of 360,070 as a plain triple valve, the port 35 has no function.

385 Q. When, and under what circumstances only, does or can the port 35 perform any function?

A. Only when the triple-valve piston of the appliance of 360,070 has moved beyond the limit required for its operation as a triple valve proper, and caused communication to be opened directly from the train-pipe to the brake-cylinder.

386 Q. In his answer to Q. 6, Mr. Boyden states (pp. 18, 19) that "To apply the brakes fully with the auxiliary reservoir pressu-e by the final movement of the piston 12, a sufficient amount of air is gradually exhausted from the main air pipe to move the piston its full stroke. This will bring the valve port 35 coincident with the passage 22 and thereby establish communication from the auxiliary reservoir to the brake-cylinder and fully apply the brakes with the reservoir pressure."

Is or is not this statement of Mr. Boyden's true and correct in fact?

420 A. The statement of Mr. Boyden is incorrect. The intent of this statement is to make it appear that in practical operation, when it is desired to get full auxiliary reservoir pressure in the brake-cylinder, it is necessary to cause the triple-valve piston to move so that the port 35 will register with port 22, when, as a matter of fact, if such operation is desired, it can only be done by moving the triple-valve piston to a position that will cause port 31 to register with port 22. When port 35 is in the position described by Mr. Boyden, valve 41 will also be open; and the air in the brake-cylinder will be combined train-pipe and auxiliary reservoir air.

387 Q. As a matter of fact, is any such operation as the gradual exhaustion of air from the main air pipe to move the piston its full stroke, in order to apply the brakes fully with the auxiliary reservoir pressure by the final movement of the piston 12, either prescribed in patent 360,070 or performed in the actual operation of quick-action triple valves similar to the appliance of said patent?

A. No.

388 Q. To what extent do you agree with Mr. Boyden's statement in folio 75 page 19 (D. R.) as to the "essential features" of the quick-action triple valve of patent 360,070?

A. I substantially agree with Mr. Boyden as to the first of the essential features, with some limitations, and disagree with him as to the second.

389 Q. To what extent do you agree with Mr. Boyden's statement in folio 82, p. 21 (D. R.) as to the "essential features" of defendants' quick-action triple valves, plate XI 1891 catalogue?

A. I agree with him as to the first of the essential features, with some limitations, and I disagree with him as to the second.

390 Q. As a practical expert in quick-action automatic brakes, please state what you consider to be the "essential features" of practical operation of the quick-action triple valve of patent

421 360,070, and state to what extent you find the essential features of practical operation of defendants' quick-action triple valves (plate IX 1889 catalogue and plate XI 1891 catalogue) to be in correspondence with those of the quick-action triple valve of patent 360,070?

A. There are two essential features in practical operation of the quick-action triple-valve structure shown in the patent 360,070. One of them is, that all of the function of triple valves as performed prior to 1887, must be obtained by means of the travel of the triple-valve piston through a limited portion of its stroke. Second, that the travel of the triple-valve piston for a greater distance than is required to perform the operations of a triple valve prior to 1887, will cause air from the train-pipe to enter the cylinder directly.

I find these essential features of operation of the appliances of 360,070, in the defendants' quick-action triple valves as shown in plate IX defendants' 1889 catalogue and plate XI defendants' 1891 catalogue.

391 Q. To what, if any, material extent or degree do such structural differences as may exist between defendants' quick-action triple valves and that of patent 360,070, affect the identity of the essential features of practical operation which you state to exist in your last answer?

A. Such structural differences as exist in the two devices do not affect their practical operative identity.

In each case the triple-valve piston moves within definitely defined limits to perform the functions of triple valves prior to 1887, and, in each case, it is essential that the piston should make a further travel before air from the train-pipe can directly enter the brake-cylinder.

392 Q. In his answer to Q. 12, defendants' witness J. B. Church, alleges that there is a difference "in principle or mode of operation" between the device of patent 360,070 and the defendants' device. Please state whether or not this assertion of Mr. Church is
422 correct or well-founded, and if it is not, state what you understand to be the "principle" or "mode of operation" of the appliance of patent 360,070, and state in what, if any, particular, either of principle or mode of operation, the defendants' quick-action triple valves differ from the appliance of patent 360,070.

A. Mr. Church is incorrect in his statement that there is a difference in principle or mode of operation in the defendants' quick-action triple valves, as compared with the appliance shown in 360,070.

It is essential to the practical operation of both of these quick-action triple valves, that they shall perform the functions of plain triple valves, and, in addition thereto, that under certain conditions, air from the train-pipe shall pass into the brake-cylinder. It is also necessary that air from the auxiliary reservoir shall also pass into the brake-cylinder to unite with the air that has entered from the train-pipe. It is also essential that when air from the reservoir enters the brake-cylinder and causes the pressure to become higher than the air in the train-pipe, that a check-valve, or its equivalent, shall prevent the flow of pressure from the brake-cylinder, into the train-pipe.

These are the essential operative requirements of the structures referred to.

In all of the structures referred to, the functions of the plain triple valves are performed in substantially the same manner by the traverse of the triple-valve piston with some of its valves through a portion of its travel. In every instance, when it is desired that air from the train-pipe should enter the brake-cylinder, it is necessary that a further traverse of the triple-valve piston shall be caused to take place, for the purpose of opening communication directly between the train-pipe and the brake-cylinder, so that air may pass from the train-pipe to the brake-cylinder without first entering the auxiliary reservoir.

To render it possible for air from the train-pipe to flow into the brake-cylinder, when there is open communication between them, it is essential that the pressure in the brake-cylinder should be less than that in the train-pipe, and if there is not a considerable
423 difference in these pressures, the intended operation of the structures will be defeated. In the operation of these quick-action triple valves to open direct communication from the train-pipe to the brake-cylinder, by means of the further traverse of the triple-valve piston, the construction of the devices in question is such, that communication is open between the auxiliary reservoir and the brake-cylinder, before direct communication is made between the train-pipe and the brake-cylinder, and some air from the auxiliary reservoir enters the brake-cylinder before the direct communication is established.

If the passage leading from the auxiliary reservoir to the brake-cylinder, which is opened by the movement of the triple-valve piston before direct communication is made between the brake-pipe and the brake-cylinder, were not restricted in size, the operation of these constructions for the purpose of causing air to enter directly from the train-pipe to the brake-cylinder could not be performed, for the following reasons:

It is primarily essential that the triple-valve piston shall move a greater distance to open direct communication between the train-pipe and the brake-cylinder, than it is required to move in performing plain triple-valve functions. In the structures in question, to cause the piston to move a greater distance, it is essential that a greater force should be made available to overcome the resistance of the piston, to travel beyond the point necessary for plain triple-valve work. The force available for moving the triple-valve piston is brought into action by creating a difference of pressure on the opposite sides of the triple-valve piston. For the purposes of *applying* brakes, pressure is reduced on the train-pipe side of the triple-valve piston, and, if but a portion of its travel is required, as in the making of graduating applications of the brakes, a moderate reduction of pressure is made in the train-pipe, which causes the piston to move to a point at which communication is opened between the auxiliary reservoir and the brake-cylinder. The fall of
424 pressure on the inner or reservoir side of the triple-valve piston, combined with the definite resistance which the pis-

ton meets at this point, causes it to stop in its travel, and when the pressure in the auxiliary reservoir has been reduced by its expansion into the brake-cylinder, to a point where it is slightly lower than the pressure on the train-pipe side, the piston will then move in a direction to close the opening between the auxiliary reservoir and the brake-cylinder.

To effect the further travel of the triple-valve piston, so that direct communication can be made between the train-pipe and the brake-cylinder, it is necessary that a reduction of pressure be made, on the train-pipe side of the triple-valve piston, sufficiently greater than that on the auxiliary reservoir side, to overcome the resistance to further travel beyond the plain triple-valve position, caused by the pressure of air on the back of valve 22 in defendants' 1891 valve, and valve 15 of defendants' 1889 valve, and by the spring 39 and friction of the slide-valve 41, in the structure shown in patent 360,070.

To cause this difference of pressure, it is necessary that air pressure be lowered on the train-pipe side of the triple-valve piston, by the opening of the engineers' valve, more rapidly than it is made on the auxiliary reservoir side by the passing of air from the auxiliary reservoir to the brake-cylinder, and, to enable the necessary difference of pressure to be obtained, it is essential, in all of the structures in question, that the flow of air from the inner side of the triple-valve piston shall be restricted when communication is made between the auxiliary reservoir and brake-cylinder.

In the defendants' 1891 quick-action triple valve, the proper flow of air from the auxiliary reservoir to the brake-cylinder is regulated by the size of port B and in the 1889 quick-action triple valve by a similar port *e*.

In the structure shown in patent 360,070 the proper proportioning of ports 35 and 31 accomplishes the same result, and in the same manner.

425 While it is essential, in these structures, that the further travel of the piston should open direct communication between the train-pipe and the brake-cylinder, it has already been pointed out that such opening would accomplish no useful result, unless, at the time of opening the direct communication between the train-pipe and the brake-cylinder, the pressure in the brake-cylinder should be somewhat less than the pressure in the train-pipe.

Each of the structures in question has a non-return check-valve, located in the line of direct communication between the train-pipe and the brake-cylinder. During the period of the application of the brakes by means of the plain triple-valve portion of the structures, this check-valve is held to its seat, in a direction to prevent the flow of air from the train-pipe to the brake cylinder. It is essential in each of these structures, when it is desired that direct communication should be made between the train-pipe and the brake-cylinder, that the force that keeps the check-valve to its seat shall be reversed so that the check-valve will be opened, permitting air to flow directly from the train-pipe to the brake-cylinder.

In defendants' 1891 quick-action triple valve, this check-valve is designated by the numeral 26, and, in defendants' 1889 quick-action triple valve, by the numeral 9. In the structure shown in patent 360,070, this check-valve is indicated by the numeral 49.

In the defendants' structures, when the complete travel of the triple-valve piston is made for the purpose of opening direct communication between the train-pipe and the brake-cylinder, the opening of valve 22 (15) by this further movement, causes a considerable reduction of pressure on the inner side of check-valve 26 (9) because of the relatively larger size of the opening controlled by valve 22 (15) as compared with port B (*e*).

Adjourned to Tuesday, December 12, 1893, at 10.30 a. m.

426 NEW YORK, *December* 12, 1893—10.30 a. m.

Met pursuant to adjournment.

Present: Counsel as before.

The deposition of the witness, H. H. Westinghouse, is here suspended, by consent, to admit of the examination of Mr. T. J. Hogan, who is about to leave the city.

THOMAS J. HOGAN, a witness produced on behalf of complainants, being duly sworn, deposes and says, in answer to interrogatories propounded to him by J. Snowden Bell, Esq., of counsel for complainants, as follows, to wit:

393 Q. What is your name, age, residence, and occupation?

A. Thomas J. Hogan, am over 38 years of age; residence, Pittsburgh, Pa.; and am a mechanical engineer.

394 Q. State the nature and extent of your education and experience as a mechanical engineer, and of your experience, if any, with automatic air brakes?

A. My education and experience as a mechanical engineer was obtained at the United States Naval Academy at Annapolis, Maryland, where I went through the full course for cadet engineers, and graduated in the year 1883, and was, from that time, an officer in the engineer corps of the United States Navy, until about October, 1886. I was not in active service from July, 1884, until March, 1886, but was during that time on waiting orders. From about the first of August until the 12th of October, 1886, or within a few days of that time, I was in active service on board the cruiser "Atlanta," and took part in the test of the machinery on board of the "Atlanta."

During part of the time that I was on waiting orders, I was assistant examiner in the division of steam-engineering in the
427 United States Patent Office, that is, from October 9, 1884, until some time in July, 1886, and, after resigning from the United States Navy about the middle of October, 1886, I returned to the Patent Office in the same position October 16, 1886, and remained in that position until January, 1890. In April, 1885, the class of steam and air brakes was assigned me for examination, and I continued to examine that class until I left the Patent Office, which was, I think, some time in July, 1886. On my return to the

Patent Office, in October, 1886, or shortly after, the class of steam and air brakes was again assigned to me, and I continued to examine that class, (the title of which was afterwards changed to fluid-pressure railway brakes) during the remainder of my time in the Patent Office.

Since leaving the Patent Office, I have been employed by the Westinghouse Air Brake Company, in connection with work in the preparation of applications for patents on fluid-pressure brake devices, and, in that time, have had a good deal of experience in the preparation of specifications and claims of patent applications, and also in connection with tests of brake devices.

395 Q. By reference to the copy of file-wrapper and contents of the Westinghouse patent No. 360,070 in suit, I find an official letter therein dated January 14, 1887, bearing the signatures "F. Fowler, ex.," and "T. J. Hogan."

Please state whether you are the T. J. Hogan whose signature appears on this letter, and whether the examination of this application was made by you.

Objected to as immaterial and irrelevant.

A. The examination of that application was made by me, and there is on file in the Patent Office a letter written by me on that date and bearing my signature.

396 Q. I also find in the said certified copy an amendment dated January 19, 1887, and endorsed "Amend't B. Filed Jan. 20, 1887,"
in and by which amendment the applicant's attorney can-
428 celed the following subject-matter, which appeared between
lines 21 and 29, page 13, of the specification as filed, to wit:
"Further, while in the specific construction described and shown, the function of admitting air from the main pipe is performed by a valve separate from that which effects the preliminary admission of reservoir pressure to the cylinder, a modification in which the same office is performed by a valve integral with the main valve and formed by an extension thereof, would be included in and embody the essential operative features of my invention."

I also find that the same amendment inserted a disclaimer, which appears between lines 94 and 103, page 4, of the patent.

Please state, first, whether or not any oral hearing or hearings was or were accorded by you to the applicant's solicitor, in the course of the application for patent 360,070, which are not noted upon the record of said application, and, second, under what circumstances or conditions the cancellation above referred to came to be made?

Objected to as incompetent, irrelevant and immaterial.

A. There were oral hearings in connection with the application, from a short time after it was filed, at different times, until a short time before the application was patented.

In connection with the canceled paragraph, among other things, the hearings related to the question as to whether the attorney would prefer to cancel the paragraph which referred to modifica-

tions not shown in the drawings, or whether he would illustrate it by an additional figure or figures in the drawing.

I don't know that he was requested to do either of these
429 things, but I know that his attention was called to the fact that the practice in the office required him to do one or the other.

397 Q. To what extent was the rule of the office requiring descriptive matter in the specification, not illustrated in the drawings, to be either illustrated or canceled, enforced in the division of steam engineering, during your term of service therein as assistant examiner?

Objected to as irrelevant and immaterial.

A. I think it was enforced in every instance, except, perhaps, in some case of carelessness or oversight, and, while it was the rule based on decisions of the Commissioner of Patents, and was the general practice in the office, in other divisions, there was one particular reason, in addition, why it was always insisted upon in that division, and that reason was, that by having all of the modifications shown in the drawing, the examiners, in looking for references, were able to make an examination more easily and quickly than they would be able to do if they had to refer to the specification.

398 Q. In case the applicant's attorney had neglected to either cancel the paragraph referred to, or to illustrate it by an additional figure or figures in the drawings, after his attention had been called to the fact that the practice in the office required him to do one or the other, what would have been your duty, and what would you have done in the premises?

Objected to as hypothetical, incompetent, irrelevant and immaterial.

A. My duty would have been to require the attorney either to cancel the descriptive matter or to illustrate it in the drawings. I suppose I would have required him, ordinarily, either to cancel the descriptive matter or to illustrate it in the drawings.

399 Q. In what manner or how would you have made this requirement?

430 Same objection, and further objected to because the question is based upon a mere supposition contained in the preceding answer.

Counsel for complainants suggests that inquiries addressed to a former officer of the United States Patent Office, relatively to the nature and scope of his duties as such officer, in connection with subject-matter in this cause, are free from the objections urged by defendants' counsel, and further, that it clearly appears, from the witness' last preceding answer, that he has stated what he believes his action would have been in the performance of such duties.

A. I would have made it by means of an official letter.

400 Q. To what, if any, prior patent did the clause of disclain inserted by amendment B refer?

Objected to as incompetent.

A. It referred to patent No. 280,285, granted to G. A. Boyden Ju 26, 1883, at the time that the official letter of January 14th, 18 was written, and, after that, the attention of the attorney was call to a similar construction to that shown in the patent to Boyden being illustrated in patent No. 163,242 to C. H. Perkins, May 1 1875.

401 Q. In calling the attention of the applicant's attorney to t fact that the practice of the office required him either to cancel t paragraph referred to in Q. 396 or to illustrate it, did you do with the intention of requiring that said subject-matter should disclaimed, in and by the cancellation, if the attorney elected to pu sue that course, or did you understand that such cancellatio would be or operate as a disclaimer of such subject-matter?

431 Objected to as leading, incompetent, and, so far as concern the witness' understanding, at the time, immaterial.

A. There was no connection between the cancellation of the par graph and the construction shown in the patents to Boyden an Perkins, so far as any requirement of mine was concerned. Th cancellation of the paragraph, appearing in the same amendmen with the disclaimer, indicates that the disclaimer referred to som thing else besides what was contained in the canceled paragrap If the disclaimer was intended merely to cover the constructio referred to in that paragraph, the disclaimer would be unnecessar when the paragraph was canceled.

I have no knowledge of requiring any disclaimer whatever, bu I know that the terms of the claims rejected described subject-mat ter which, while intended for a different purpose, and not perform ing the same function as in the application of patent 360,070, wa shown in the patents to Boyden and Perkins.

All that part of the foregoing answer from and after the word "was concerned," to and including the words "when the paragrap was canceled," further objected to by defendants' counsel, as being not fact, but a mere supposition, inference, or argument of the wit ness, and therefore entirely incompetent.

Cross-examination *de bene esse:*

402 X Q. When you left the Patent Office in January, 1890, di you go immediately into the employment of the Westinghouse Ai Brake Company?

A. I did, but was not in their offices. I went to work in th office of Mr. George H. Christy, and under his direction, and so fa as I knew at the time, I was being employed by him.

403 X Q. You resigned your position in the Patent Office to g into Mr. Christy's employment?

Objected to as irrelevant and immaterial.

432 A. Yes, sir. The only communication I had with any one on the subject before leaving the Patent Office was with Mr. J. Snowden Bell, who was associated with Mr. Christy in his business, and with Mr. Christy himself, through personal interviews with both of these gentlemen in Washington, D. C., the understanding being that I was to be employed to attend to and perform whatever work might be required of me in connection with their patent business.

404 X Q. How long did you remain in Mr. Christy's office?

A. I remained there up to the present time, and am still in his office, although I am employed by the Westinghouse Air Brake Company.

405 X Q. How long after you entered Mr. Christy's office before you ascertained that you were employed, not by Mr. Christy, but by the Westinghouse Air Brake Company?

Same objection, which is continued without further notice to this line of examination.

A. In reply to that question, and also to correct what might be an inaccuracy in my answer to X Q 402, I will say that about six months after I left the Patent Office, I was informed that I was partly in the employment of the Westinghouse Air Brake Company, and while I stated, in answer to 402 X Q., that I went immediately into the employment of the Westinghouse Company, I did not know it at the time, and was not informed until about six months later, and was not given to understand then that I was exclusively employed by them. The question came up I think in July of 1890, about the time that I had obtained some patents of my own on air-brake appliances. Previous to that time, and for some time after that, I had done a great deal of work in connection with the preparation and prosecution of applications before the Patent Office, the
433 subject-matter of which had nothing whatever to do with air-brake appliances, or with the work of the Westinghouse Air Brake Company.

I think that Mr. Christy's business was such that he was required to increase the force in his office, and that that was the reason why I was employed by him, but I do not think his original intention was to employ me on work exclusively for the Westinghouse Air Brake Company. I know that I was not exclusively confined to air-brake work for some time after I discovered that I was partly employed by the air-brake company.

405 X Q. In answer to Qs. 400 and 401, you state, in substance, that the terms of the claims rejected in the Westinghouse application for patent 360,070, describe subject-matter shown in the patent to Perkins, No. 163,242, dated May 11, 1875, although, in said Perkins patent, said subject-matter was intended for a different purpose and did not perform the same function as in said Westinghouse application; what rejected claims of the Westinghouse application did you there refer to?

Objected to as irrelevant, immaterial and not proper cross-exami-

nation, the witness not having been interrogated in chief as to the claims of the patents referred to in the question, or of any other patents, and it not being competent for him to construe said claims.

Defendants' counsel states that the witness gave the testimony referred to, without objection from complainants' counsel, and it is therefore proper subject for cross-examination.

A. In reply to question 400 I mentioned patents to Boyden and Perkins, but made no reference to the construction shown in these patents, as being embodied in, or coming within the claims of application of patent 360,070, but, in reply to Q. 401, I stated that the terms of the claims rejected describe subject-matter, which,
434 while intended for a different purpose, and not performing the same function as in the application of patent 360,070, was shown in the patents to Boyden and Perkins. The claims of the application of patent 360,070 referred to were the original claims 1 and 2, rejected in the office letter of January 14, 1887.

406 X Q. Where did you find in said Perkins patent the subject-matter described in those two claims?

Same objection.

A. The terms of the first claim of the application of the patent No. 360,070 as originally filed, was rejected on the patent to Boyden, because Boyden's construction showed a triple valve provided with a device for admitting air directly from the main air pipe to the brake-cylinder. The claim referred to had no further limitation by which the reference to Boyden's patent could be avoided. While it was very clear that the operation of the device shown in patent 360,070 was very different from that shown in the patent 280,285 to Boyden, the terms of the claim described a construction which was shown in the Boyden patent, and Boyden's patent was given as a reference for the purpose of calling the attention of the attorney to the fact that this claim might be construed to cover a device such as that shown by Boyden. Substantially the same reasons applied in the case of the original second claim of patent No. 360,070. The patent to Perkins was not given as a reference, because the patent to Boyden was considered a better reference, and it is not customary to multiply references for the same claim, and it was not certain that the Perkins patent would operate in exactly the same way that the Boyden device did, but the Boyden patent had claims covering a construction similar to the Perkins patent, in which a passage led from the train-pipe to the auxiliary reservoir and opened into the space above the triple-valve piston, and this space communicated with the brake-cylinder in the application of the brakes,
435 the passage from the train-pipe to the auxiliary reservoir and the space above the triple-valve piston being controlled by a check-valve. It was the resemblance of the Perkins patent to the construction shown in the Boyden patent 280,285, in regard to that particular construction, which I think was then covered by claim 1 of the Boyden patent, the subject-matter of the claim 1 of the Boyden patent being shown in the patent to Perkins.

Answer objected to by complainants' counsel as irrelevant and immaterial, whatever objection the Patent Office may have had as to claims 1 and 2 of the application of the patent 360,070, as originally filed, having been waived and withdrawn by the acceptance and allowance of an amended claim in lieu of the original claim 1, and the acceptance and allowance of claim 2 as filed, without change or modification in any particular. The answer is further objected to as incompetent, in so far as it construes the claims of any of the patents referred to.

407 X Q. Do you find any provision, and if so what, in said Perkins patent, for admitting air directly from the train-pipe to the brake-cylinder?

A. No. While I don't remember exactly why the Perkins patent was not given, with the Boyden, as a reference, it was probably due to the fact that the Perkins patent, while it showed the one-way passage referred to in claim 1 of the Boyden patent 280,285, did not show a "device for admitting air directly from the main air pipe to the brake-cylinder."

The passages were substantially the same as those shown by Boyden, but the device shown by Perkins would probably not operate in that way.

408 X Q. Then there was nothing in the Perkins patent that anticipated the device or combination referred to in the original first claim of the application of Westinghouse for patent No.
436 360,070, which claim specified "a triple valve provided with a device for admitting air directly from the main air pipe to the brake-cylinder;" am I correct?

A. There was nothing in it, except its resemblance to the Boyden patent, which resemblance was found in the passages, which were substantially the same as those shown in the Boyden patent.

409 X Q. Referring to the passages of the Perkins patent, I understand that the feeding-in passage admitted air from the train-pipe side of the triple-valve piston to pass around to the space at the opposite end of the triple-valve piston, which space was in open communication with the auxiliary reservoir, so that the air admitted from the train-pipe charged the auxiliary reservoir, and also the space at the end of the triple-valve piston opposite to the train-pipe end of the piston; am I correct in this?

Objected to as irrelevant, immaterial and not proper cross-examination.

A. Yes, I think you are.

410 X Q. In that respect, what material difference was there between the triple-valve device of the Perkins patent and any other known "automatic" triple-valve device, for example, the triple-valve device of the Westinghouse patent No. 144,006, dated October 28, 1873?

Same objection.

A. So far as being exposed to the pressure of reservoir air on one

side and train-pipe air on the other side, the piston shown in patent 144,006 is arranged similarly to that shown in the Perkins patent.

411 X Q. The said Westinghouse patent 144,006 and the said Perkins patent are also substantially the same, in respect to the fact that the train-pipe air, in charging the reservoir, passes, through a proper port, to the space at the end of the triple-valve piston opposite to the train-pipe end of said piston, which space is in open
437 communication with the auxiliary reservoir, and is not in open communication with the brake-cylinder at the time when air is passing from the train-pipe to said space; are they not?

Same objection.

A. They are not substantially the same, because there is a difference in the arrangement of the port through which the air is fed from the train-pipe to the auxiliary reservoir, and also in the means for controlling that port, which, in the Perkins patent, is different from that shown in the Westinghouse patent 144,006.

412 X Q. They are substantially the same in regard to the function of admitting train-pipe air to the space at the opposite end of the triple-valve piston, and holding it there in open communication with the auxiliary reservoir, but not in open communication with the brake-cylinder, at the time while the air is entering said space from the train-pipe; are they not?

Same objection.

A. In that respect they are substantially the same.

413 X Q. The Westinghouse patent No. 144,006 shows a valve which is the equivalent for the check-valve for controlling the feeding-in passage; does it not?

Same objection.

A. Yes, it does.

414 X Q. Said Boyden patent No. 280,285 differs both from the Perkins and from the Westinghouse No. 144,006, in the fact that, with the Boyden device, the air can be charged directly from the train-pipe into the brake-cylinder, while, with the other two mentioned, the air cannot be charged directly from the train-pipe into the brake-cylinder; am I correct in this?

Same objection.

A. Yes, I think you are.

T. J. HOGAN.

438 Testimony of Mr. H. H. Westinghouse resumed:

(A. to Q. 392 continued:) The higher train-pipe pressure on the train-pipe side of the check-valve 26 (9), overcomes the force holding the check-valve 26 (9) to its seat, and air from the train-pipe passes directly into the brake-cylinder, through the port controlled by the auxiliary valve 22 (15).

Air at the same time flows from the auxiliary reservoir into the

brake-cylinder and when the united pressure is greater than the train-pipe pressure, the force that opened check-valve 26 (9) will be reversed, and the check-valve will become seated, thereby preventing the flow of air from the brake-cylinder into the train-pipe.

In the structure shown in patent 360,070, check-valve 49 is also normally held to its seat, when brakes are applied for a graduated application. When it is desired to make direct communication between the train-pipe and the brake-cylinder, for the purpose of admitting air directly from the train-pipe to the brake-cylinder, the opening of the valve 41, by a greater traverse of the piston than is required for plain triple-valve work, reverses the force operating to hold the check-valve 49 in a closed direction, and it is moved from its seat, and air passes directly from the train-pipe to the brake-cylinder.

The passage leading from the check-valve to the brake-cylinder is in direct communication with the brake-cylinder, and there will always be the same pressure in this passage and the brake-cylinder. To accomplish the reversal of the force that holds the check-valve to its seat, it is necessary that a considerably less pressure shall be present in the brake-cylinder and the check-valve passage, when the valve 41 is opened and train-pipe pressure is admitted to the outer side of the check-valve 49, for, if the flow of pressure from the auxiliary reservoir to the brake-cylinder is not restricted, then,
upon the opening of the valve 41, the train-pipe pressure
439 admitted by valve 41 would be unable to overcome the force
that tends to hold the check-valve 49 in a closed position.

For this reason, as well as others already stated, the passages leading from the auxiliary reservoir to the brake-cylinder in the mechanism shown in patent 360,070, have been properly and necessarily restricted.

The function and operation of the closing of the check-valve 49, for the purpose of preventing the back flow of pressure from the brake-cylinder into the train-pipe, is the same in defendants' structures and that shown in patent 360,070.

From the foregoing explanation it will be seen that, in both defendants' device and that of patent 360,070, it is essential that the plain triple-valve work shall be performed by a portion of the stroke of the valve piston. It is necessary, for the purpose of opening direct communication between the train-pipe and the brake-cylinder, that the triple-valve piston shall make a greater traverse than is required for plain triple-valve work.

In both devices, it is essential that restricted passages shall be properly located between the auxiliary reservoir and the brake-cylinder, to enable the proper force to be created to cause the triple-valve piston to make its greater travel than is required for plain triple-valve work, so that direct communication can be had between the train-pipe and the brake-cylinder.

In both devices, it is also necessary that the passage or passages leading from the auxiliary reservoir to the brake-cylinder shall be properly restricted, so that the flow of air from the auxiliary reservoir to the brake-cylinder, prior to the opening of the direct com-

munication between the train-pipe and the brake-cylinder, shall not be sufficiently great to cause the pressure in the brake-cylinder to equal or approximate the pressure in the train-pipe, otherwise there can be no flow of air from the train-pipe to the brake-cylinder.

It is also essential, in all the structures referred to in the question, that the flow of pressure from the auxiliary reservoir to the brake-cylinder shall be restricted, so that the force tending
440 to hold the non-return check-valves to their seats may be reversed, permitting the valve to open and the air to flow directly from the train-pipe to the brake-cylinder.

In view of these considerations, I am of the opinion that the principle and mode of operation of the defendants' valves, and the structure shown in patent 360,070, are substantially identical. The structural differences in these devices require a different location of the same parts in each device, with respect to each other, but I do not consider that such different arrangements in any way affect the principle or mode of operation of these structures.

NOTE.—The enumeration of the questions here changes by reason of the interposition of the deposition of Mr. T. J. Hogan between the former and the latter portion of Mr. H. H. Westinghouse's answer to Q. 392.

415 Q. While you have, in your last preceding answer, not only positively stated that instead of there being a difference in principle or mode of operation between the defendants' devices and the device of patent 360,070, as alleged by Mr. Church, that the devices are in fact *identical* in principle and mode of operation, and have given your reasons for your statement, I think it may be desirable for the enlightenment of the court that you should consider separately the several alleged differences recited by Mr. Church, and I will therefore endeavor to state briefly what I understand his alleged differences to consist in, and ask you to consider them separately, as presented in this and other questions in this regard.

In the first place I understand Mr. Church to allege that the patentee, Mr. Westinghouse, contrived "an additional valve element" and compelled the triple valve to actuate this additional element to admit train-pipe air to the brake-cylinder, and that, on the other hand, Mr. Boyden compelled "the triple valve
441 itself" to admit train-pipe air to the brake-cylinder without the aid of any auxiliary-valve element.

How far, if at all, is this allegation of difference warranted by the facts?

A. The facts do not in any way support the claim of an alleged difference. The valve structure in patent 360,070 contains a valve device for opening communication from the train-pipe to the brake-cylinder and the operation of this valve device is not essential in the performance of triple-valve work of the kind performed prior to 1887. This valve device is indicated by the numeral 41 in patent 360,070.

In the defendants' structures there is provided a valve device for

opening direct communication between the train-pipe and the brake-cylinder, and this valvular device is also unessential for the performance of plain triple-valve work. This valve is indicated by the numeral 22 in the 1891 catalogue, and 15 in the 1889 catalogue.

In respect to this feature of construction, both structures have, in their organization, a valve device that is supplemental to the plain triple-valve portion of the structures.

416 Q. If the valve device 41 of patent 360,070 and the valve device 22 (15) of the defendants' structures, were suppressed, what effect would such suppression have upon the capability of the several structures to perform the work of a plain triple valve, a "triple valve proper," or work of the kind performed by triple valves as known prior to 1887, and secondly, what effect would such suppression have upon the capability of the several structures to perform quick-action or emergency work, or, in other words, to effect the direct admission of train-pipe air to the brake-cylinder in making an application of the brakes?

A. The suppression of the parts named would not affect the operation of the valve devices in question for the performance of work as done by triple valves prior to 1887. It would, however,
442 totally destroy their capacity for admitting air directly from the train-pipe to the brake-cylinder.

Adjourned to Wednesday, December 13, 1893, at 10.30 a. m.

NEW YORK, *December* 13, 1893—10.30 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of H. H. WESTINGHOUSE resumed:

417 Q. In support of his allegation in answer 12, to the effect that, in patent 360,070, the admission of train-pipe air to the brake-cylinder was effected by "an additional valve element," while, in the defendants' devices, it was effected by "the triple valve itself," Mr. Church pretends that Mr. Boyden, as "the inventor of the defendants' device," by separating the piston chamber from the valve chamber, and restricting the passage for air from the auxiliary reservoir to the valve chamber, introduced what Mr. Church terms "the new principle of momentary differential pressures."

To what extent, if at all, was such "principle," a *new* principle, at and prior to the date of application of either of the Boyden patents, and to what, if any, greater extent is such "principle," or the mechanical means by which it is practiced, embodied in defendants' devices than in the quick-action triple valve of patent 360,070?

A. It is evident that Mr. Church's lack of practical experience has caused him to fail to observe that the principle of momentary differential pressures is not new, and that it is not embodied for the first time in defendants' structures.

All practically operative triple valves, whether of the kind
443 used prior to 1887, or those subsequently devised, perform

their functions only when momentary differential pressures are created by the means of restricted passages.

The presence of restricted passages, for the purpose of creating momentary differential pressures, is required for the same purpose in the defendants' structures as in that shown in patent 360,070, and it does not exist in any different degree in any of these structures.

418 Q. Mr. Church further states, in answer 12, that "the device of Mr. Westinghouse acts on the mechanical principle of employing the triple valve piston to actuate a new and additional valve element to open the passage from the train-pipe to the brake-cylinder."

Assuming Mr. Church to be entirely correct in this statement, please state what kind or type of element is employed in defendants' structures "to open the passage from the train-pipe to the brake-cylinder;" what member is employed "to actuate" such element; and what, if any, difference of "mechanical principle" exists, either in the *opening* members or the *actuating* members, as between the defendants' devices and that of patent 360,070.

A. What Mr. Church describes as a new and additional valve element, is also found in the defendants' structures, and is indicated by the numeral 22 in the 1891 catalogue, and 15 in the 1889 catalogue.

No one of these additional valve elements performs any function when the devices are operated as a plain triple valve, and they all perform the same function of opening direct communication between the train-pipe and the brake-cylinder, when the piston of the triple valve makes a further travel than is required for plain triple-valve operation.

In all of these structures the triple-valve piston is the member that actuates the additional valve element, and they are all caused to operate by a travel of the triple-valve piston for a greater distance than is required in the operation of plain triple valves.

Absolutely no difference of mechanical principle exists in
444 the opening and actuating members of the defendants'
structures, as compared with those of the device of patent
360,070.

419 Q. Mr. Church further says, in answer 12: "Mr. Westinghouse uses a new and auxiliary valve, not a part of the triple valve; Mr. Boyden utilizes the feed-valve of the old triple valve."

I understand Mr. Church to mean, defendants' check-valve 26 (9).

To what extent, if at all, would the utilization of said check-valve 26 (9) enable the defendants' devices to effect the admission of train-pipe air directly to the brake-cylinder, if the new and additional valve element 22 (15) of said defendants' devices was suppressed; and to what extent, if at all, would the use of "a new and auxiliary valve, not a part of the triple valve," in the device of patent 360,070, enable said device to effect the admission of train-pipe air directly to the brake-cylinder, if the check-valve 49 of said device was suppressed?

A. If the new and additional valve element was not present in the defendants' devices, there could be no direct admission of train-pipe air directly to the brake-cylinder, and the presence of the check-valve 26 (9) would have no effect in maintaining the capability of these structures for admitting train-pipe pressure directly to the brake-cylinder.

The use of a new and auxiliary valve, not a part of the triple valve, in the device of patent 360,070, would not effect the admission of air directly from the train-pipe to the brake-cylinder, if the check-valve 49 was suppressed.

120 Q. Mr. Church further states, in answer 12, that: "Mr. Westinghouse actuates his new valve by the impact of the triple-valve piston," but, by some inadvertence, Mr. Church has omitted to make a comparative statement of what actuates the new and additional valve element 22 (15) of defendants' devices.

Will you please state by what said new additional valve element 22 (15) of defendants' devices is actuated?

445 A. The new and additional valve element 22 (15) of defendants' devices is actuated by the impact of the triple-valve piston, when it travels a greater distance than is required for plain triple-valve work. In this respect the operation is identical with that of the device shown in patent 360,070.

421 Q. Mr. Church further states, in answer 12, that "Mr. Boyden actuates the old feed-valve, such as that of his 1883 patent [meaning, as I understand, defendants' check-valve 26 (9)], by the differential air pressure momentarily established in the triple-valve chamber."

Mr. Church has again inadvertently omitted to make a comparative statement of what actuates the check-valve 49 of the device in patent 360,070, and I will be glad if you will do so?

A. I understand Mr. Church's statement is to the effect that, by a reduction of pressure on the brake-cylinder side of the check-valve 26 (9), of defendants' structures, the higher pressure on the train-pipe side forces the check-valve open, and that this difference of pressure is brought about by means of restricted passages.

The mode of operation of the check-valve 49, in the device of patent 360,070, is practically the same. When train-pipe pressure is admitted to the train-pipe side of the check-valve 49, it forces the check-valve 49 open, because restricted passages, leading from the auxiliary reservoir to the brake-cylinder, prevent the flow of pressure to the brake-cylinder side of the check-valve, thereby permitting the higher train-pipe pressure to overcome the resistance of the lower brake-cylinder pressure.

422 Q. Mr. Church in answer 12, argues that because the suppression of the valve 41 and port 42, in the device of patent 360,070, and the suppression of the partition 9, in the Boyden device, in each case prevents quick action, *therefore* the parts named, in each case, respectively, "constitute the quick-action device as distinguished from the old triple valve."

446 Mr. Church has again inadvertently omitted to make a comparative statement as to the effect, on the one hand, of

the suppression of defendants' new and additional valve element 22 (15), relatively to the valve 41 and port 42 of patent 360,070, and, on the other hand, of the suppression of the partition and restricted passage between the auxiliary reservoir and brake-cylinder of patent 360,070, relatively to the partition 9 and restricted passage of defendants' devices.

Please make the comparison a complete and parallel one, and state the result?

A. The suppression of valve 22 (15), in the defendants' devices, and the suppression of valve 41, in the device shown in patent 360,070, which valves relatively perform the same function in all of these structures, would prevent quick action in each case, and these structures would then be only capable of performing plain triple-valve work.

The presence of the partition and restricted passage between the auxiliary reservoir and the brake-cylinder of the defendants' devices, is essential for the purpose of creating a sufficient difference of pressure, between the reservoir side and the train-pipe side of the triple-valve piston, to enable a sufficient stroke of the piston to be made to open valve 22 (15). It is also necessary that this partition and restricted passage should exist for the purpose of creating a reversal of force that holds the check-valve 26 (9) to its seat, so that it may be opened in a direction to permit air to flow from the train-pipe to the brake-cylinder. If this partition and restricted passage is removed, or if the restricted passage is not properly located and proportioned, with reference to ports controlled by valve 22 (15) and valve port 40, then the differential pressures required to move the triple-valve piston to its completed stroke, and to force the check-valve 26 (9) open, will not be created, and the function of quick action will not be performed.

In the device shown in patent 360,070, it is also essential that differential pressures shall be created between the train-pipe
447 side and the auxiliary reservoir side of the triple-valve piston, and this is obtained by the proper restriction of the passages leading from the auxiliary reservoir to the brake-cylinder. If the passages leading from the auxiliary reservoir to the brake-cylinder were not restricted, the flow of air from the auxiliary reservoir to the brake-cylinder would be so rapid as to render it impossible to lower the pressure on the train-pipe side of the triple-valve piston rapidly enough to create the differential pressures necessary to move the triple-valve piston to its completest stroke.

It is also necessary that the passage leading from the auxiliary reservoir to the brake-cylinder should be restricted, for, if this were not the case, the flow of pressure from the auxiliary reservoir to the brake-cylinder would be such as to admit an amount of pressure to the inner side of the check-valve 49, that would prevent the train-pipe pressure from overcoming and reversing the force holding the check-valve 49 to its seat, and, as it is essential for the passage of air from the train-pipe to the brake-cylinder, that this valve should be opened, the failure to provide a sufficient opening force would

cause the valve to remain seated, and prevent the flow of air directly from the train-pipe to the brake-cylinder.

It will therefore be seen that the suppression of restricted passages in all of the structures in question would, to the same degree and in the same manner, destroy their function, so far as relates to the admission of train-pipe air directly to the brake-cylinder.

423 Q. Please make another parallel suppression in the device of patent 360,070 and in the defendants' devices. That is to say, suppress, in each case, the full or further of the two traverses of the triple-valve piston, and state what would be the result in the operation of the devices, (1) as triple valves proper, performing the functions known prior to 1887, and (2) as appliances for effecting the direct admission of train-pipe air to the brake-cylinder.

A. In the devices referred to, if the traverse of the triple-
448 valve piston is restricted to a point where communication is
first opened between the auxiliary reservoir and the brake-cylinder, they will perform all the functions of plain triple valves as used prior to 1887.

If the travel is so restricted, it will entirely destroy the capability of these structures to open direct communication between the train-pipe and the brake-cylinder.

424 Q. How far, if at all, do you find Mr. Boyden's statements on page 27 (D. R.) as to an alleged "fourth valve," and its supposed function, to be true and correct statements?

A. As I understand Mr. Boyden's statement, it is to the effect that the so-called fourth valve performs some function of the triple valve proper as used prior to 1887, and that its presence is essential to such operation.

With this understanding, I think his description and statement is entirely wrong.

The alleged fourth valve, which is controlled by port 35, is used when, and only when, the triple-valve piston is in position to establish direct communication from the train-pipe to the brake-cylinder by means of port 42, and such position is never used when the device is operated as a plain triple valve.

If his second statement is intended to mean that valve 22 performs some function, and is an essential part of the triple valve proper as used prior to 1887, or occupies the position shown in drawing 6, during the admission of air from the auxiliary reservoir to the brake-cylinder when operating as a plain triple valve, then I absolutely and entirely disagree with him.

425 Q. In drawing No. 5 of Defendants' Exhibit "Illustrative Cuts," which Mr. Boyden refers to in his statement as to patent 360,070, under the heading of fourth valve, the port 35 is shown as open, and air is indicated as passing through this port, from the
auxiliary reservoir to the brake-cylinder, by a red line. The
449 port controlled by the valve 41 is also shown as wide open,
but there is no indication of the passage of air through such port.

Does or does not said drawing No. 5, correctly illustrate the traverse of the air in the device of patent 360,070, in practical op-

eration, when the parts are in the position shown in said drawing No. 5?

Objected to, as impliedly asserting the incorrectness of said drawing No. 5, whereas said drawing was made merely to illustrate the way in which the air moves from the auxiliary reservoir to the brake-cylinder, when the triple valve is in the position shown in said drawing, and in respect to all that it was intended and used to illustrate, it is entirely correct.

The foregoing objection of defendants' counsel objected to by counsel for complainants, as being wholly improper and incompetent, for the reason that it makes defendants' counsel a witness in this cause. Complainants' counsel submits to the court that the drawing having been offered in the condition in which it appears, whatever error or inaccuracy it embodies, if any, is open to correction only by the testimony of witnesses and not by the statements of counsel.

A. I think the effect of drawing No. 5 is misleading, as it does not correctly indicate the flow or traverse of air that takes place in practical operation, when the triple-valve piston is in the position indicated in the drawing. There should be a line showing that air is passing from the train-pipe through the port controlled by the valve 41.

426 Q. To what extent is your answer to Q. 424 applicable to the statement of defendants' witness Church in folios 680, 681, pp. 170, 171.

A. So much of it as relates to the valve device of patent 360,070 is applicable to Mr. Church's statement.

450 427 Q. In folios 110, 111, p. 28 (D. R.) Mr. Boyden recites "four valves," as forming the "triple valve," that is, the triple valve proper, in patent 360,070 and in defendants' quick-action triple valves. To what extent is such recital a true and correct one?

A. His recital is incorrect.

Port 35 in the device of patent 360,070, and valve 22 of defendants' device, are not essential to, and do not perform plain triple-valve functions.

428 Q. What, if any, plain triple valve, or triple valve proper, functions are in practice, performed, or are, in practice, required to be performed, in the device of patent 360,070, or in the defendants' quick-action triple-valve devices, by any valve or valve element, other than the first, second, and third enumerated by Mr. Boyden in folio 110, p. 28 (D. R.)?

A. None.

429 Q. Is, or is not, the statement of Mr. Boyden, in the first paragraph of folio 116, p. 29 (D. R.), that one of the four valves forming the triple valve proper, in the defendants' structures, admits the main-air-pipe air to the brake-cylinder simultaneously with the auxiliary reservoir air when producing quick action, a true and correct statement?

A. I regard his statement as incorrect, for the reason that the op-

eration of the triple valve proper, in the defendants' device, is performed by three valves. The fourth valve referred to is only necessary when it is required to establish direct communication between the train-pipe and the brake-cylinder.

430 Q. Mr. Boyden states on p. 30 (D. R.) that "This distinctly shows that the complainants' device uses two valves to perform the quick application of the brakes, one of which belongs to the *triple valve proper* while the other is an *auxiliary valve additional* to the triple-valve structure."

While I understand from your preceding testimony that you disagree with other statements of Mr. Boyden which seem to me to be substantially to the same effect as this one, I wish you
451 would state whether or not you find this specific statement to be a true and correct one?

A. The statement is incorrect, because the port 35 of the device of patent 360,070, forms no part of the triple valve proper.

431 Q. Is, or is not, the following statement made by Mr. Boyden, on pp. 20 and 21 (D. R.), as to the operation of defendants' quick-action triple valve, plate XI defendants' 1891 catalogue, a true and correct statement, to wit:

"To apply the brakes fully with the auxiliary reservoir pressure by the final movement of the piston, sufficient pressure is gradually exhausted from the main air pipe to move the piston its full stroke. This will unseat the main valve 22 and thereby establish full communication between the auxiliary reservoir and brake-cylinder, and apply the brakes with the full auxiliary reservoir pressure.

"The operations just described are those of the 'triple valve,' *per se*, and are such as are used in the art prior to 1887."

A. The statement of Mr. Boyden is incorrect, for the reason that the valve 22 cannot be lifted from its seat to admit auxiliary reservoir pressure to the brake-cylinder, to perform the operation of plain triple valves as used prior to 1887, without admitting pressure directly from the train-pipe to the brake-cylinder.

432 Q. To what extent is your last preceding answer applicable to the statement of Mr. Church as to defendants' 1889 device, in the paragraph on page 196 (D. R.) commencing "To apply the brakes with full power in the shortest possible time," etc., understanding said paragraph to be comprehended within the statement which he makes subsequently on same page, to wit: that "the operations described are generally the same as those performed by the 'triple valve proper'"?

452 A. It is entirely applicable.

433 Q. Is your statement in answer 431, as to the incapacity of the valve 22 of defendants' quick-action triple valve, plate XI defendants' 1891 catalogue, merely a statement of your opinion, or is it based upon any actual and practical tests made by you with said device of defendants?

A. It is based upon actual practical experiments with defendants' device.

434 Q. Have you witnessed a repetition, by Mr. Boyden, of his experiments with defendants' quick-action triple valve, plate XI

defendants' 1891 catalogue, recited in his deposition, and if so, whe and where?

A. I have witnessed a repetition of the experiments in questio by Mr. Boyden, at the works of the Boyden Brake Company, a Baltimore, on November 7, 1893.

435 Q. What, if any, results were developed, in the experiment which were repeated in your presence by Mr. Boyden, which wer at variance with the experiments made by you as stated in you answer 433, or which tended to show any incorrectness in you statement in answer 431?

A. The results of the experiments which I witnessed in the work of the Boyden Brake Company, were substantially the same as thos I had previously obtained in similar experiments, and did not affec the opinion I had previously formed, and which I have expressed with respect to the functions and capabilities of the valve 22.

436 Q. In X Q. 152, Mr. Boyden was referred to the description o the operation of the Westinghouse quick-action triple valve of paten 360,070, contained between lines 80, p. 3, and 51, p. 4, of the speci fication of said patent, and was asked if it was not the fact that th functions, and the *only* functions, of the valve mechanism, as recite in such description, are,

1st. To admit air from the main air pipe to the auxiliary reser voir.

453 2d. To admit air from the auxiliary reservoir to the brake cylinder through the port controlled by the graduating valve 29.

3d. To exhaust air from the brake-cylinder to the atmosphere.

4th. To effect the admission of air directly from the main air pipe to the brake-cylinder, accompanied by a subsequent admission of auxiliary reservoir air through the port 35.

Mr. Boyden replied, "Yes, those are the functions set forth in the patent specification referred to."

Please state whether or not you agree with Mr. Boyden, and state also whether or not the quick-action triple valve of patent 360,070 performs, in practice, any function whatever other than those speci- fied in the question.

A. I agree with Mr. Boyden, and the structure of patent 360,070 does not perform any other functions than those recited in the question.

437 Q. How many, and which, of the functions recited in the last preceding question were performed by triple valves such as were known in the art prior to 1887?

A. Only the first, second and third functions recited in the last preceding question were performed by triple valves prior to 1887.

438 Q. From your familiarity with the art in air brakes for rail- roads, please state when first, and by whom, a triple-valve device was produced having the capacity of performing the first, second and third functions recited in Q. 436, and having in addition thereto the capacity of effecting, when desired, the admission of air

directly from the main air pipe to the brake-cylinder in an application of the brakes?

Objected to as immaterial and irrelevant, for the reason that such function is not covered by the claims of the patent in suit, nor is the patent, broadly, a generic patent covering the principle or mode of operation employed in effecting such function.

451 A. The first structure of the kind that performs the operations described, is shown in the device of patent 360,070, and was invented by George Westinghouse, Jr.

Adjourned to Thursday, December 14, 1893, at 10.30 a. m.

NEW YORK, *December* 14, 1893—10.30 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of H. H. WESTINGHOUSE resumed:

439 Q. When first, if you know, was the structure which was invented by George Westinghouse, Jr., and is shown in patent 360,070 as stated in your last preceding answer, put into practical service?

A. It was in the latter part of 1886, or first part of 1887.

440 Q. From your practical knowledge of, and experience with, quick-action automatic air brakes, state briefly what are the functions, and the *only* functions, performed in practice by the defendants' quick-action triple valves shown in plate IX defendants' 1889 catalogue and plate XI defendants' 1891 catalogue?

A. The functions of these structures, and the only functions, are, *first*, the admission of air from the train-pipe to the auxiliary reservoir through the check-valve 26 (9), the port B (*e*) and the port A (*b*.)

Second, the admission of air from the auxiliary reservoir to the brake-cylinder, for the purpose of the application of brakes, performed by triple valves prior to 1887, by means of valve port *i* in 1891 device, and by valve 13 in the 1889 device, with a partial movement of the triple-valve piston.

Third, the release of air pressure from the brake-cylinder to the atmosphere.

455 *Fourth*, the admission of train-pipe pressure directly from the train-pipe to the brake-cylinder, combined with the admission of the auxiliary reservoir pressure, when the triple-valve piston travels a greater distance than is required for the performance of triple-valve work as done prior to 1887.

441 Q. How many, and which, of these functions, are, operatively and in results, in correspondence with the functions performed by triple valves such as were known in the art prior to 1887?

A. Three functions, the first, second and third enumerated in my above answer.

442 Q. What is the function, and the *only* function, in practical operation, of the valve 22 of defendants' quick-action triple valve,

plate XI defendants' 1891 catalogue, and the corresponding valve 15 of plate IX defendants' 1889 catalogue, and by what mechanical means or member is said valve actuated?

A. To open direct communication between the train-pipe and the brake-cylinder.

The valve referred to is actuated by the triple-valve piston, when it makes a traverse greater than is required for plain triple-valve work.

443 Q. In what, if any, particular, of function, means of actuation, or operative relation to the other members of the appliance which perform the first, second and third functions recited in your answer 440, does the valve 22 of defendants' 1891 quick-action triple valve, or the corresponding valve 15 of defendants' 1889 quick-action triple valve, differ from the valve 41 of the structure of patent 360,070?

A. It does not differ.

444 Q. To what extent, if at all, is the valve 22 (15) of defendants' devices a necessary, or a practically useful, member of said devices, for any purpose or function whatever, other than that of admitting air directly from the main air pipe to the brake-cylinder?

A. The presence of valve 22 (15) of defendants' structures, for any other purpose than the direct admission of train-pipe air
456 to the brake-cylinder, is useless and unnecessary, and is an injury to the operation of these devices as plain triple valves.

445 Q. Referring you to X Qs. 230 and 232 to Mr. Boyden (D. R.), and his answers thereto, please state to what extent, if at all, you find his said answers to be in conformity with that portion of your last preceding answer which states that "the presence of valve 22 (15) of defendants' structures, for any other purpose than the direct admission of train-pipe air to the brake-cylinder is useless and unnecessary."

A. I find that the answers referred to are in substantial conformity with my statement that "the presence of valve 22 (15) of defendants' structures for any other purpose than the direct admission of train-pipe air to the brake-cylinder is useless and unnecessary."

446 Q. From your practical knowledge of, and experience with, automatic air brakes, state whether or not defendants' quick-action triple valves could be so operated in practical railroad service as to raise the valve 22 (15) from its seat, without affecting a quick-action application of the brakes, in and by such unseating of the valve.

A. In practical operation the valve 22 (15) cannot be lifted from its seat, to perform any operation of braking, other than the direct admission of train-pipe air to the brake-cylinder, until the brakes have been fully applied by auxiliary reservoir pressure. After the brakes are fully applied by auxiliary reservoir pressure, the further traverse of the triple-valve piston will cause valve 22 (15) to be lifted from its seat, but no additional braking effect will be produced by such opening.

447 Q. Please state whether the check-valve 26 (9) and the port controlled thereby, are of the normal dimensions required to serve

for the purpose of the passage of air from the train-pipe to the auxiliary reservoir, or to serve as what has been termed by defendants' witnesses a "feeding-in valve," or are of larger dimensions, and if the latter, state why, and state also what effect is produced, in practical service, by the use of a valve and port of larger
457 dimensions than would be necessary for the purposes of the feeding-in valve.

A. The proportions of the valves referred to are enormously greater than the requirements of a feeding-in valve call for, being more than two hundred times the size used in a practically operative triple valve. And the apparent reason for the adoption of the proportions shown in defendants' structures, is for the purpose of enabling this check-valve to perform the functions of the non-return check-valve as shown in the device of patent 360,070.

If the valve referred to, and the feeding-in port, were made as shown in the drawings of defendants' devices, the structures would be practically inoperative in regular service.

As stated in a previous answer by me, the construction of all practically operative triple-valve devices requires the use of restricted passages for the purpose of creating momentary differential pressures.

In the defendants' devices, on account of the disproportionate size of the check-valve 26 (9) and the passage B (*e*), it would be found impossible in practice to create the necessary differential pressures on the opposite sides of the triple-valve piston to cause it to move in the direction to effect the opening of the passage leading from the brake cylinder to the atmosphere.

I have seen quick-action triple-valve structures made by the defendant corporation, in which the feeding-in passage is differently located, and is properly restricted, and this further confirms my view of the impracticable character of the structures shown in defendants' catalogues of 1889 and 1891. The use of a check-valve to control a feeding-in passage, has been found to be objectionable and unnecessary, in a practically operative triple valve, and, to the best of my knowledge, has never been used in any form of triple valve that is practically operative in general service. A restricted port, properly located, has been found to meet all of the requirements of a practically operative triple-valve device.

458 448 Q. To what extent, if at all, is a construction, such as is shown in patent 220,556, in which the port or passage leading from the auxiliary reservoir to the brake-cylinder has what I believe you have characterized as a double control, that is, that it may be either partially or entirely uncovered, essential in the operation of a triple valve proper as known prior to 1887?

A. It is not essential or desirable, in the construction of a triple valve for practical operation, to do the work performed by triple valves prior to 1887.

449 Q. As a matter of fact, do or do not the defendants' structures possess the capacity of producing the same effect, in a service application of the brakes, as is produced if the piston and valve H of

patent 220,556 are allowed to make the extreme traverse which the patent shows they are capable of making?

A. They do not.

450 Q. I understand the defendants' witnesses to maintain that the port 35 of the appliance of patent 360,070 through which, as you have stated, the auxiliary reservoir air passes to the brake-cylinders, when, and only when, a quick-action application of the brakes is being made, is a part of the triple valve proper as used prior to 1887, and also that said port 35, as a part of the triple valve proper, is essential to the device, in effecting a quick-action application.

Please state whether or not said port 35 could be eliminated from the structure, without interfering with the performance of the quick-action function, and illustrate, by a drawing, a form of said structure in which the port 35 is eliminated.

A. The port 35 can be eliminated without interfering with the function of quick action.

I produce a tracing prepared under my direction illustrating a modification in which port 35 is eleminated.

By making a cavity marked *x*, in the face of the slide-valve, and connecting this cavity with the port 31, all of the capabili-
459 ties of this structure for performing plain triple-valve work,
and for performing the function of quick action, would be substantially the same as the construction shown in the device of patent 360,070, having the port 35.

Counsel for complainants offers in evidence the tracing referred to by the witness, and the same is marked "Complainants' Exhibit Westinghouse Modification."

(Here follows diagram marked p. 458*a*.)

Defendants' counsel objects to the answer and to the exhibit offered in evidence, on the ground that, in the so-called "modification," the port 35 is not eliminated, except in the sense that that particular form of port is eliminated, and another form of port is manufactured as a substitute for it.

The foregoing objection objected to by counsel for complainants, as making defendants' counsel a witness.

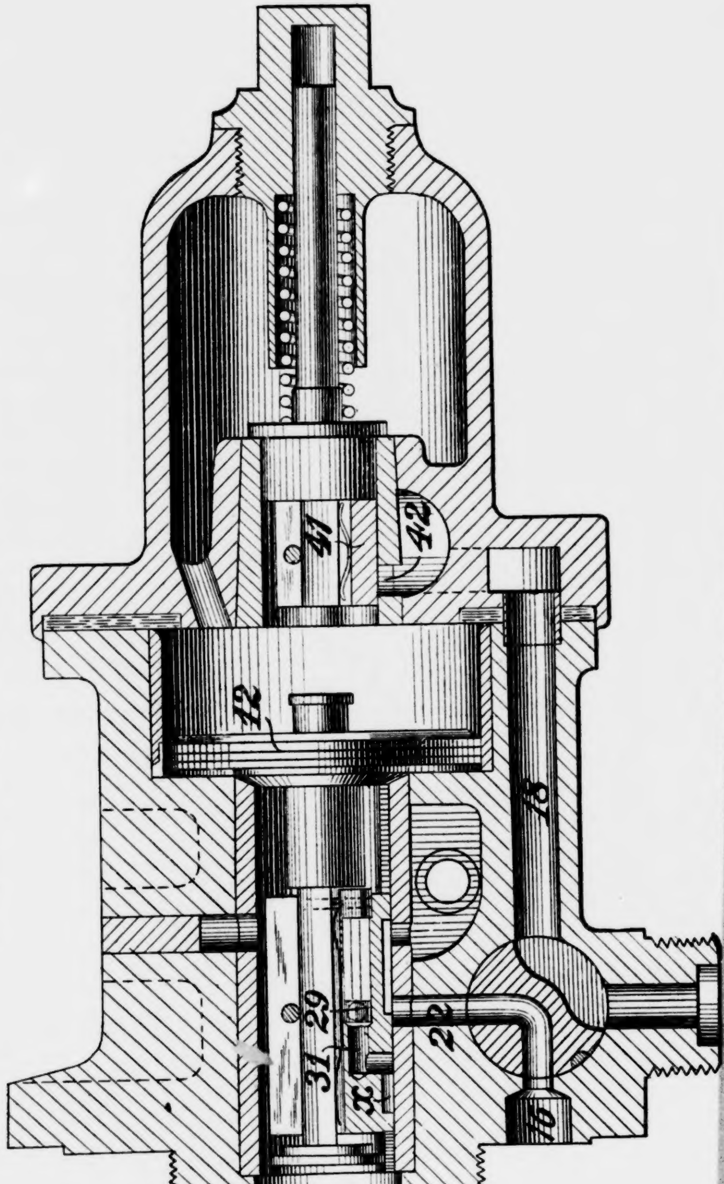
451 Q. In the modification shown in the tracing you have produced, what, if any, function is performed by the valve recess *x*, which communicates with the port 31 controlled by the graduating valve 29, in any operation whatever of the structure as a triple valve proper known prior to 1887?

A. None.

452 Q. It is stated in defendants' 1891 catalogue, page 29, referring to defendants' quick-action triple valve plate XI, that:

"The actions of this valve in graduating, full-service application quick action and the release, are the same as the new Westinghouse quick-action valve, thereby producing the same results in braking,

Complainants' Exhibit "Westinghouse Modification."



ich renders cars equipped with the two valves perfectly inter-angeable—the hose coupling being the same."

Assuming said statement to be true, what would be the
0 necessary and inevitable operations of the defendants' device, when used on a car or cars of a train containing other cars uipped with the quick-action triple valve of patent 360,070?

Objected to as assuming that the quotation made from the de-idants' 1891 catalogue is a comparison of the defendants' quick-ion triple valve with the quick-action triple valve of the patent suit, whereas, on the contrary, it is a comparison of the defend-ts' quick-action triple valve with the quick-action triple valves ide by the complainants under patents to Mr. George Westing-use, Jr., later in date than the patent in suit and for another and ferent construction.

Counsel for complainants submits that the defendants' catalogue, ich has heretofore been offered as an exhibit, is the best evidence d that it is not proper or competent to attempt to explain or odify the subject-matter of said catalogue by the statements of unsel.

A. The necessary and inevitable operation of the defendants' de-ce, when used under the conditions stated, would be the perform-ce of plain triple-valve work by a portion of the traverse of the ple-valve piston, and the opening of direct communication between e auxiliary reservoir and the train-pipe, when a further traverse the triple-valve piston is made for the purpose of causing a quick-tion operation.

453 Q. Assuming the words "the new Westinghouse quick-action lve," in the extract from defendants' catalogue made in Q. 452, mean a quick-action triple valve similar to that described and own in any patent to Mr. George Westinghouse, Jr., later in date an the patent in suit which is within your knowledge, to what, any, extent would your answer to Q. 452 be modified, under such sumption?

A. Not at all, so far as I now remember the constructions referred to.

1 454 Q. In his answer to R. D. Q. 238, Mr. Boyden states that in making a quick-action application of the brakes, with e appliance of patent 360,070, a greater amount of air pressure ould be admitted to the brake-cylinder, through the port 35, than rough the port 22 which is controlled by valve 41. Do you, or t, accord with this view?

A. Undoubtedly Mr. Boyden is in error with respect to this state-ent. In the operation described, a sufficient quantity of air passes rough port 42 to produce a pressure of from thirty-five to thirty-ght pounds in the brake-cylinder, while, through port 35, a suffi-ent quantity passes into the brake-cylinder to produce a total essure in the brake-cylinder of about sixty pounds. It is, there-re, clear that the greater amount of air, in making an emergency plication, passes through the port 42.

455 Q. To what extent, if at all, do you agree with the view

expressed by Mr. Boyden in answer to R D. Q. 239, as to the pressure exerted in the brake-cylinder by the air taken from the train-pipe, in making a quick-action application of the brakes by the appliance of patent 360.070?

A. I substantially agree with the statements made by Mr. Boyden, except that I have found, by experiment, that a higher pressure than twenty-five pounds is usually realized from train-pipe pressure in making a quick application.

456 Q. I understand the statements of Mr. Church, in folios 851 to 853, on page 213, and first paragraph of page 14 (D. R.), to the effect that the results produced by the valve 41 and port 42 of the appliance of patent 360,070, are produced in defendants' devices, directly by the triple valve proper, and that Mr. Boyden has succeeded in making a triple valve proper perform the operation of quick action without the addition of anything corresponding in name, construction, or mode of operation, with said valve 41 and port 42, to be in substance repeated and summarized in Mr.
462 Church's answer 12, which you have heretofore considered.

It may be, however, that I am in error as to this understanding, and I will therefore ask you to state whether or not the statements of Mr. Church referred to on pages 213 and 214 (D. R.) are true and correct statements.

A. They are entirely untrue and incorrect.

457 Q. To what extent do you find the comparative statements of the "valves or valve functions" in the structure of patent 360,070 and in defendants' structures, respectively, made by Mr. Church on page 214 (D. R.) to be a true and correct statement?

A. I think it correct in non-essential particulars, and untrue and incorrect in respect to the essential ones.

458 Q. Mr. Church states, on page 215 (D. R.), that in the device of patent 360,070, "it is requisite and necessary that the auxiliary valve should be moved by the piston to uncover a port for the admission of train-pipe air to the brake cylinder, whereas in defendants' structures there are no auxiliary valves," etc. To what extent is this statement a true and correct one?

A. The first part of it is true and correct, and the last part is untrue and incorrect.

459 Q. From your observation of a repetition of the experiments made by Mr. Boyden, as well as from those made by yourself, state whether or not you find the opinions and conclusions expressed by Mr. Church in his answer 13, commencing with folio 914, p. 229 (D. R.) as to the Boyden experiments, to be warranted or well founded?

A. It does not seem to me that they are either warranted or well founded.

460 Q. Please produce and explain a series of illustrations, on a large scale, prepared under your direction, for use at the hearing, of triple-valve devices such as you consider relevant and appropriate in elucidating questions of fact involved in this cause?

A. I produce the drawings asked for, being 27 sheets of
463 drawings, made to a large scale, so as to be used for exhibition

in court at the hearing, these drawings being respectively numbered and entitled as follows:

No. 1, Jones pat. 166,386.
2, pat. 168,359 (release).
3, " (application).
4, 172,064 (release).
5, " (application).
6, 220,556 (release).
7, " (application).
8, Eng. pat. 3000 of 1879.
9, pl. B. 25, compl'ts' 1886 catalogue (release).
10, " " (application).
11, Boyden pat. 280,285 (release).
12, " " " (application).
13, pat. 360,070 (release).
14, " (service app'n).
15, " (quick action).
16, " (quick action, showing check-valve).
17, def'ts' 1889 valve (release).
18, " (service application).
19, " (quick action).
20, def'ts' 1891 valve (release).
21, " (service app'n).
22, " (quick action).
23, the "triple valve proper" of Boyden's 1891 appliance (release).
24, ditto (application).
25, Boyden's 1891 quick-action device with Westinghouse "triple valve proper."
26, Boyden's 1891 quick-action device with modified differential passages and Westinghouse triple valve proper.
27, Boyden's 1891 quick-action device without passage "B," and with slide-valve of pat. 360,070.

464 Drawings 1 to 22 inclusive, are enlarged views, made in accordance with the drawings of the several patents and the plates of the defendants' catalogues referred to, including instances showing the parts in release, application, and quick-action positions, as marked on the different sheets. They are substantially the same in proportion and details as the small originals from which they are taken, although there may possibly be some minor errors in making the enlargements, as I have not yet had time to examine them critically.

The remaining sheets, Nos. 23 to 27 inclusive, I will now explain.

Drawing No. 23 illustrates the triple valve proper portion of the Boyden 1891 appliance, with the auxiliary valve 22 removed, and a fixed bushing substituted for it. This figure shows the structure in the release position.

Drawing No. 24 represents the same modification with the parts in position for the application of the brakes.

Drawing No. 25 represents the Boyden quick-action device with the Westinghouse triple valve proper.

Drawing No. 26 shows the Boyden 1891 quick-action device with modified differential passages and Westinghouse triple valve proper.

Drawing No. 27 represents Boyden's 1891 quick-action device without passage "B," and with slide-valve of patent 360,070.

Counsel for complainants offers in evidence the 27 sheets of drawings referred to by the witness, and they are marked by the examiner "Complainants' Exhibit Illustrations."

Defendants' counsel reserves the right to object to these said twenty-seven drawings, or any of them, for due cause, after he shall have had time to examine them and become familiar with them.

Adjourned to Friday, December 15, 1893, at 10. a. m.

465 NEW YORK, *December* 15, 1893—10 a. m.

Met pursuant to adjournment.

Present: Counsel as before.

Deposition of H. H. WESTINGHOUSE resumed.

Cross-examination *de bene esse :*

461 X Q. How long have you been in the employ of the Westinghouse Air Brake Company?

A. Since the year 1872.

462 X Q. During that period, from 1872 to the present time, have you been familiar with the various triple-valve mechanisms put into use by said company?

A. I have.

463 X Q. Have you also been familiar with the various patents on triple-valve mechanisms taken out by your brother, George Westinghouse, Jr.?

A. Not to the extent that I have been familiar with the practical construction and operation of these devices.

464 X Q. Do you know what was the first patent that he took out on a triple-valve mechanism, if so, state what patent?

Objected to, if intended to ask of the witness anything as to the scope of any patent taken out by Mr. Geo. Westinghouse, Jr., or as to what is covered by, or claimed in, any patent taken out by Mr. Westinghouse.

Defendants' counsel states that he does not propose to cross-examine the witness as to the scope of the claims of any patent, inasmuch as that matter was avoided in the direct examination.

Counsel for complainants replies that notwithstanding defendants' counsel's disclaimer of such intention, the language in the question "What was the first patent that he took out on?"
466 would seem to clearly cover the enquiry as to what subject-matter was covered by, or claimed in, the patent. If defendants' counsel will limit his enquiry as to what patent first *illustrates* or *describes* a triple-valve mechanism, there can be no possible objection, and no room for doubt as to what is enquired about.

Defendants' counsel states that the witness may consider this question as modified according to the suggestion of complainants' counsel, and answer it with that understanding.

A. I am not now sufficiently familiar with the subject, to state which is the first patent he took out on triple-valve mechanism.

465 X Q. So far as you know, was not the patent of August 12, 1873, No. 141,685, the first of his patents which described or showed such a mechanism?

A. As before stated, I am not sufficiently well informed to answer with any degree of accuracy, but my impression is that this is not the first patent of Mr. George Westinghouse, Jr., which illustrates a triple valve, as I remember that one form of triple valve, and possibly more, was or were actually made before the one illustrated in patent No. 141,685 was constructed.

466 X Q. Did the device of patent No. 141,685 go into actual use on railways, and if so, to what extent, and how long was it continued in use before it was superseded by an improved form of triple valve?

A. A form of triple valve substantially in accordance with the illustration of patent 141,685 was experimentally used for some months on a passenger train, and, generally speaking, performed in a satisfactory manner.

467 X Q. By what was this form of triple valve superseded?

A. To the best of my recollection, the next form was one that embodied substantially the essential features of this valve, but a larger diaphragm was substituted for the purpose of operat-
467 ing the valve mechanisms, and I believe that metal was substituted for rubber in the construction of the diaphragm.

468 X Q. How long was the diaphragm used for actuating the triple valve, and when was it superseded by the piston?

A. So far as I can recollect, I should say that diaphragms were used about three years before the piston construction was adopted.

469 X Q. What was the first patent of Mr. George Westinghouse, Jr., which showed or described a triple valve with the piston substituted for the diaphragm?

A. So far as I now know, patent 144,006 is the first that shows a triple valve operated by a piston, but, as already stated, I am not sufficiently familiar with the patent question to absolutely state that this is the first triple valve that is patented having a piston to operate it.

470 X Q. Was the triple valve which is illustrated and described in patent No. 144,006 put into actual use on railways; if so, to what extent, and for how long a time before it became superseded by another and more improved form?

A. I believe it was used for a short time on a train in regular service, but I don't think it was in use, if at all, more than a few weeks. My information in respect to this matter is very indistinct.

472 X Q. Please refer to the patent granted to George Westinghouse, Jr., October 5, 1875, No. 168,359, and state whether the construction of triple valve therein described and shown was put into

actual practical use, and if so, to what extent it was used, and for how long a time before it was superseded by other and improved forms?

A. The triple valves substantially as shown in the patent referred to, were put into practical operative use to a considerable extent, and by reference to the date of the patent application, I should say that it was probably used for a period of about a year and a half or two years before any important modification was made in
468 triple-valve construction. During the time stated it is probable that it was the only form of triple valves furnished by the Westinghouse Air Brake Company in connection with automatic brake apparatus.

472 X Q. What form of triple valve superseded the triple valve of patent No. 168,359?

A. The form of triple valve having, at least, some of the modifications shown in patent 172,064.

473 X Q. To what extent was the form of triple valve shown in patent 172,064, dated January 11, 1876, put into practical use, and for how long a period did it remain in use before it was superseded by other and more improved forms?

A. I believe this form was adopted as standard about the first of the year 1876, and, with the exception of some valves similar to our previous standards, which were furnished to roads that were using the form shown in patent 168,359, it was generally used until some time during the year 1879.

474 X Q. What form of triple valves, in the year 1879, superseded the form shown in patent No. 172,064?

A. A form having the general features of improvement shown in patent No. 220,566.

475 X Q. To what extent did triple valves having the general features of the device shown in patent No. 220,556, go into practical use, and for how long a time did they remain in practical use before other important improvements were added?

A. They probably went into practical use some time during the year 1879, and were generally used on passenger trains, and locomotives and tenders, up to the year 1886. The particular construction was not found suitable for use on long trains, and another form was devised and used exclusively in connection with the brakes on freight trains. This latter form is illustrated in patent No. 243,415 to George Westinghouse, Jr., dated June 28, 1881. The form shown in patent 220,556 is still generally used on locomotives and tenders.

469 476 X Q. For passenger service, what form of triple valve, in 1886, superseded the form shown in patent No. 220,556?

A. I cannot say that the form of patent 220,556 was superseded at the date named, but, about that time, brakes were furnished for passenger cars, with quick-action triple valves substantially in accordance with the device of patent 360,070 in suit.

477 X Q. For how long, and to what extent, was the device shown in patent 360,070 actually used for passenger service?

A. I believe about three or four hundred of these valves were in

use for practical service, and they remained in use about two years.

478 X Q. On what railroad were they used?

A. On the Baltimore & Ohio railroad.

479 X Q. Were they then removed and another form of triple valve substituted; if so, what other form?

A. They were removed, and the form shown in patent 376,837 to George Westinghouse, Jr., dated January 24, 1888, which we had subsequently adopted as standard, was substituted.

480 X Q. To what extent, and for how long a period, was the form of triple valve shown in patent 376,837 used in service for passenger trains?

A. This form of valve has been used almost exclusively, since the date mentioned, up to the present time, for passenger trains.

That was our standard, which we furnished on all orders received, unless otherwise instructed. In a few instances, the form shown in patent 220,556 was specified and supplied, but the number furnished relatively to the kind shown in the patent 376,837 was very small.

481 X Q. What form of triple valve was first used by the Westinghouse Air Brake Company, to any considerable extent, on freight trains?

A. Substantially the form shown in patent 243,415 to George Westinghouse, Jr.

482 X Q. To what extent, and how long, was the form of
470 triple valve shown in patent 243,415, used by said company for freight service, before it was superseded by some other form, and what other form superseded it, and when?

A. The form of valve shown in patent 243,415 was put into use about the year 1883, and about fifty thousand were furnished before it was superseded by other forms. So far as I am aware, all of these valves are still in operation, except such as have been put out of use by the ordinary wear and tear and deterioration of such devices.

In 1886 a valve similar in construction to the one shown in patent 360,070 was made and applied to the extent of about two or three thousand sets.

Valves made in accordance with the construction of patent 243,415, were furnished to some extent after 1886, and they are furnished, to a small extent, even at the present time, principally for the purpose of repairs to similar apparatus previously supplied.

483 X Q. What was the first quick-action triple valve that was adopted by the Westinghouse Air Brake Company, as their standard form of quick-action triple valve, and when was it adopted?

A. The form shown in patent 360,070, and it was adopted during the year 1886.

484 X Q. When was it superseded by the adoption of another standard form of quick-action triple valve, and what was the latter form?

A. It was superseded by one of the form shown in patent 376,837, in the latter part of 1886 or the early part of 1887.

485 X Q. In your answer to X Q. 482, you state that "in 1886 a valve similar in construction to the one shown in patent 360,070

was made and applied to the extent of about two or three thousand sets;" on what railroads were these valves applied?

A. On the Atchison, Topeka & Santa Fé R. R., the Union Pacific R. R., and the Northern Pacific R. R.

486 X Q. Are those two or three thousand sets still in use on those railroads; if not, by what were they superseded, and when?

471 A. So far as I am informed, they are still in use, as we have never substituted any other form for them.

487 X Q. Comparing the structures shown in patents No. 220,55 and No. 243,415, of Mr. George Westinghouse, Jr., what, if any material and substantial differences are there between the triple valve devices of said two structures, and why was the structure o patent 243,415 any better adapted to freight service than th structure of patent 220,556?

A. The general form shown in patent 243,415 is a much les expensive structure than the one shown in patent 220,556, and i capable of performing every operation of triple-valve work equall as well as the form shown in patent 220,556. The operative ad vantage of the valve of patent 243,415, as compared with that o patent 220,556, is due to the proportioning of the port that lead from the auxiliary reservoir to the brake-cylinder. The operatio of valves constructed like those shown in patent 220,556, whe used on a long train, has proved very objectionable, on account o the quicker application of the brakes on the front portion of th train than on the rear, on account of the size of the passage lead ing from the auxiliary reservoir to the brake-cylinder, that may b opened under some operations of this valve. This objectionabl action was modified, to a considerable extent, in the device show in patent 243,415, by a proper proportioning of the port leadin from the auxiliary reservoir to the brake-cylinder.

If the larger opening of the port from the auxiliary reservoi to the brake-cylinder, for the purpose of getting a quicker applica tion of the brakes under some circumstances, were desirable, i could be readily and more cheaply obtained in the structure o patent 243,415, without the necessity of resorting to the more ex pensive and less desirable method shown in patent 220,556.

472 Such proportioning of the passage in valve of patent 243,41 would not affect its capacity for performing all the function of a plain triple valve in the most perfect degree.

488 X Q. Why could the larger opening of the port from th auxiliary reservoir to the brake-cylinder, be readily and mor cheaply obtained, in the structure of patent 243,415, than in that o patent 220,556?

A. My statement was to the effect that it could be more readil and cheaply obtained in patent 243,415 than it *is* obtained in th construction shown in patent 220,556. In the construction show in patent 243,415, the only change required would be the making o a larger hole or passage leading from the auxiliary reservoir to th brake-cylinder, and the making of this larger hole could be as con veniently done and with as little cost as the smaller one. No othe change would be required, to change the capacity for a differen

degree of rapidity of the application of brakes under certain circumstances.

In the construction, as shown in patent 220,556, the opening of the larger port from the auxiliary reservoir to the brake-cylinder under certain circumstances, *requires* that the traverse of the triple-valve piston and its valves shall be considerably greater than is required to make the less rapid application of the brakes, and this requirement of further traverse increases the length of all the principal portions of this structure fully twenty-five per cent., and its con-truction is therefore objectionable, as compared with the one shown in patent 243,415, because of its greatly increased cost, and because its peculiar construction is absolutely without operative advantage, as compared with the structure shown in patent 243,415.

489 X Q. Why would not the enlargement of the passage leading from the auxiliary reservoir to the brake-cylinder, in patent 243,415, necessitate the enlargement of the traverse of the triple-valve piston and its valve, in that structure, just as you say would be the case in the structure of patent 220,556?

A. Because the lateral enlargement, or widening, of the
473 passages leading from the auxiliary reservoir to the brake-cylinder, in structure of patent 243,415, would increase the size of the passage from the auxiliary reservoir to the brake-cylinder, without the necessity of increasing the travel of the triple-valve piston.

490 X Q. Do you refer to the difference between the form of said passage, at that part of it which passes through the cock K, and are you comparing the form shown at k^1, figure 2 of patent 243,415, where said passage is elongated in cross-section, with the form of said passage in patent 220,556, at that part of it which passes through the cock K, where it is marked k^1, and which appears to be round in cross-section?

A. I do not refer to the passages mentioned. The meaning I intended to convey was this: Assuming that the port s^1 and C of patent 243,415 are round, (a fact which I know to be the case in actual construction) the lateral widening of these ports would necessarily make a larger opening leading from the auxiliary reservoir to the brake-cylinder without any increase of the travel of the triple-value piston.

491 X Q. In patent 243,415, does the specification say anything about making the port C oblong or flattened, or does the drawing of said patent show the port C thus constructed?

A. The specification does not seem to refer to any particular form of construction of the port C, and I presume the ports are intended to be circular.

492 X Q. Was the triple valve of the Westinghouse patent No. 141,685, dated August 12, 1873, capable of graduating the pressure upon the brakes?

Objected to as immaterial.

A. I am not quite sure what is meant by the term "graduation."

493 X Q. Was said triple valve capable of applying the brakes

with less than their maximum pressure, and of adjusting the degree of pressure with which they could be applied?

474 A. Yes.

494 X Q. How did it perform the graduating operation, and how did it apply the brakes with full pressure?

A. By making different degrees of adjustment of train-pipe pressure.

495 X Q. Was the apparatus of patent 141,685 an automatic air-brake apparatus, in the sense in which that term has been generally used within the last twenty years or more?

A. It was the triple-valve portion of what is known as automatic-brake apparatus.

496 X Q. What is meant by the expression "automatic air brake," in the sense in which that term has been employed during the last twenty years or more?

A. I presume the term "automatic" relates more specifically to the capability that this brake possesses of applying, under some circumstances, without the aid of manual manipulation.

497 X Q. Under what circumstances does this automatic action take place?

A. Substantially any condition of circumstances in which train-pipe pressure is reduced below auxiliary reservoir pressure, to a degree that enables the triple valve to operate.

498 X Q. For example, does it take place in case the train should be broken in two and the train-pipe parted?

A. It usually does. In fact, it always does when the brake is in an operative condition.

499 X Q. Assume the triple valve of patent No. 141,685 to be used on a train, and the train to break in two, and state just how and by what movement the triple valve would act automatically to apply the brakes, and whether it would apply them with maximum force?

A. Under the conditions named, I presume the brakes would be applied with maximum force. By the separation of the train, all pressure would escape from the upper side of the diaphragm
475 *n*, and the pressure in the auxiliary reservoir acting on the under side of the diaphragm *n*, will force it in an upward direction, resulting first in the closure of the port h^2, leading from the brake-cylinder to the atmosphere, finally opening the valve *a*, thus permitting the stored pressure in the auxiliary reservoir to flow through port *o*, into the brake-cylinder, thereby applying the brakes with maximum force.

500 X Q. In the triple valve of patent 141,685, in this automatic operation by which the valve *a* is lifted from its seat, so as to allow auxiliary reservoir pressure to pass into the brake-cylinder and apply the brakes with maximum force, was this automatic unseating of valve *a*, one of the functions of the triple valve?

A. The unseating of valve *a* was one of the functions of the triple valve in the patent in question, but the unseating of the valve *a*, by the reduction of pressure made by the separation of the train, was the same function, whether the valve was unseated by a reduc-

tion in the train-pipe pressure made in the way described, or in any other way. That is to say, the triple valve in question had no capability of operation that could not as well be performed by the manipulation of the engineer's valve, as by the reduction of train-pipe pressure made by the separation of the train or the bursting of the train-pipe.

501 X Q. Was it intended that the triple valve of patent 141,685, in case of the rupture or separation of the train-pipe, should unseat the valve *a*, and admit the reservoir pressure to charge the brake-cylinder with maximum force?

A. Beyond doubt it was, as no obvious means seem to have been provided to keep the valve from performing this function.

502 X Q. In that apparatus, then, one of the triple-valve functions was the unseating of valve *a* and thereby the application of the brakes with maximum pressure, in case of accidental rupture of the train-pipe, was it not?

476 A. The valve in question did not contain a function of the kind stated, in distinction with any other opening of the valve *a* made for the purpose of a full application of the brakes.

503 X Q. Question repeated.

A. I can make no better answer to the question than the former.

504 X Q. I did not ask you whether said function was "a function of the kind stated, in distinction with any other opening of the valve *a*," but whether it was not one of the triple-valve functions, in that structure, to unseat and open its port for the admission of maximum pressure to the brake-cylinder, in case of the accidental rupture of the train-pipe; please answer this question responsively.

A. It is one of the functions of the valve *a* to open and admit air of maximum pressure to the brake-cylinder, in case of the accidental rupture of the train-pipe, or from any other cause that will sufficiently reduce train-pipe pressure to cause the valve *a* to be opened, and remain opened until the maximum pressure is charged into the brake-cylinder.

All that part of the above answer from and after the words "or from any other cause" objected to by defendants' counsel as not responsive, but volunteered and argument-ive.

505 X Q. Will you please answer my questions responsively, reserving your arguments until they are called for. The function of the valve *a*, in opening to admit maximum air pressure into the brake-cylinder, in case of the accidental rupture of the train-pipe, was, in that structure, one of the triple-valve functions of the structure, was it not?

So much of the question as requests the witness to reserve arguments in reply until they are called for, is objected to by counsel for complainants, in view of the manifestly argumentative character of the question.

477 A. I do not wish to be understood as denying that the valve *a* will open, and charge auxiliary reservoir pressure into the brake-cylinder to a maximum degree, if a rupture in the train-pipe produces a sufficient reduction of pressure to cause such operation. Such operation is a normal one under the conditions stated, but I do not wish to be understood as admitting, or believing, that the operation described is a different mode of operation, so far as the movement of the valve *a* is concerned, as compared with the operation made by a similar reduction of pressure brought about by any other cause. I also do not wish to be understood as admitting or believing that the opening of valve *a*, under the conditions stated, is a function or operation performed only under the circumstances and conditions stated.

506 X Q. Answer objected to as not responsive and question repeated.

Objected to as already answered.

A. It is impossible for me to answer this question more responsively in view of the way it is stated.

507 X Q. The valve *a* is a part of the triple valve in patent 141,685, is it not?

A. It is.

508 X Q. It performs the function of opening to admit maximum pressure to the brake-cylinder in case of the accidental rupture of the train-pipe, does it not?

A. It does.

509 X Q. If it is a part of the triple valve, and performs the function stated, is not that function, thus performed by a part of the triple valve in that structure, a triple-valve function?

A. The triple valve in question will operate in the manner described under the conditions stated, but I am not prepared to describe the operation, under the conditions stated, as a function of a triple valve.

478 510 X Q. Do you wish the court to understand you as *denying* that it is a function of a triple valve?

A. I wish to be understood as believing that the opening of the valve *a*, is, in itself, a function of the triple valve proper, and that I do not regard the coupling of this operation with some peculiar or particular kind of reduction of train-pipe pressure, or of a reduction made in some particular way, as a proper description of a triple-valve function.

511 X Q. In your answer to X Q. 505, you state that such operation is a normal one under the conditions stated. In your answer to X Q. 501 you stated that it was an intended operation under the conditions stated. In your answer to X Q. 507 you stated that the valve *a*, which performs this operation, is a part of the triple valve. Now I want to know whether or not this normal and intended operation or function of the valve *a*, under the conditions stated, is a triple-valve function, or is a function of something else and not of the triple valve; please answer this question responsively.

A. I think the operation stated is properly described as a function

of admitting air from the auxiliary reservoir to the train-pipe through the port opened by valve *a*, such opening being caused by a reduction of train-pipe pressure brought about by the rupture of the train-pipe.

I have endeavored to answer this question, and all other questions relating to it, responsively, and have stated the facts of operation correctly, and my understanding of how I regard these operations. I do not see that I can add anything more to make myself clear.

Answer objected to by defendants' counsel as not responsive.

512 X Q. Is that function of opening valve *a* and admitting full pressure to the brake-cylinder, in case of the rupture of the train-pipe, a function performed by the triple valve, or a function performed by something else?

479 A. If the opening of valve *a*, and admitting maximum train-pipe pressure, is a function, then it seems to me it is performed by the rupture of the train-pipe and the operation of the triple valve.

513 X Q. Then, if it is performed by the operation of the triple valve, under the conditions stated, and is, as you have testified, a normal and intended operation of the triple valve, under the conditions stated, it is a triple-valve function, is it not?

Objected to as argumentative and misleading and simply intended to commit the witness to the endorsement of some particular view held by defendants' counsel, as to the meaning or application of the term "triple-valve function."

Defendants' counsel objects to the objection, as instructing the witness how to further evade the question, and states that said function either is or is not a function of the triple valve, and he proposes to find out, from this witness, whether it is the function of a triple valve or the function of something else.

Counsel for complainants deems it only just to himself to ask the attention of the court to the fact that the record shows that he has given the witness no instruction whatever.

A. I do not think the term "triple-valve function" properly describes the operation in question.

514 X Q. What do you understand the meaning of the word "function," when applied to mechanical structures, to be?

A. To the best of my knowledge at present, the best description I can give of the sense in which I have used the word "function," is to substitute the word "capability," which is the nearest comparative word I can now think of.

515 X Q. The "capability" of the structure of patent 141,685 to admit full pressure to the brake-cylinder, upon the accidental
480 rupture of the train-pipe, is a "capability" of the triple valve shown in that patent, is it not?

A. The triple valve in question has the capability of operating as described when the rupture of the train-pipe makes a sufficient reduction of train-pipe pressure. If this operation is to be described

as a capability, I think it should be stated as a capability of the valve to operate as described, when the train-pipe is ruptured.

516 X Q. The triple valve of patent 141,685 has such a mode of action that when the train-pipe is ruptured, the triple valve acts to admit, automatically, full pressure to the brake-cylinder; is not this a fact?

A. It operates, under the conditions named, in the same manner that it operates when any considerable reduction of pressure is made in the train-pipe. I do not know that I have ever thought of or described the operation of the triple valve under this circumstances as "automatic."

517 X Q. That function of the triple valve is performed automatically, under the conditions stated, is it not?

A. I think that the whole operation, under the conditions described, would generally be considered an automatic operation, as compared with a similar application produced by the use of the engineer's valve or conductor's valve.

518 X Q. Why have the Westinghouse air brakes been termed "automatic air brakes" for the last twenty years or more?

A. I should presume this term was applied to them, principally on account of the application of the brakes in the event of the parting of the train or the bursting of the train-pipe, or from any other cause that would produce a considerable reduction of pressure in the train-pipe, besides the usual methods of operating the brakes by the engineer or trainmen.

Adjourned to Saturday, December 16, 1893, at 10 a. m.

481 NEW YORK, *December* 16, 1893—10 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of H. H. WESTINGHOUSE resumed:

519 X Q. In the structure of patent 141,685, was any provision made, and if so, what, for enabling the brakes to be applied by the engineer with graduated pressure?

A. The construction shown in patent 141,685 provides for the admission of air pressure from the auxiliary reservoir to the brake-cylinder, in the various degrees less than the maximum.

That is to say, if it is desired to admit a small or limited amount of pressure to the brake-cylinder, this valve has the capacity to act in this manner, as well as to admit maximum pressure.

This regulation of the flow of air from the auxiliary reservoir to the brake-cylinder is accomplished, in this structure, by making a smaller reduction of pressure in the train-pipe than is required for a maximum application of the brakes. Assuming a pressure of seventy pounds in the train-pipe and auxiliary reservoir, and that it is desired to make an application of the brakes with moderate pressure, if pressure in the train-pipe is reduced five pounds, for instance, the pressure in the train-pipe will be sixty-five pounds, while

that in the auxiliary reservoir is still seventy pounds. The higher auxiliary reservoir pressure on the under side of the diaphragm *n*, will move it in an upward direction, which movement will cause valve *a* to be opened, thereby permitting air to flow from the auxiliary reservoir to the brake cylinder, through the ports *o* and H[1].

Air will continue to flow into the brake-cylinder until the pressure in the auxiliary reservoir is reduced to a little less than sixty-five pounds. As this pressure is a little less than the pressure on the upper or train-pipe side of the diaphragm *n*, the diaphragm
482 will be forced in a downward direction, causing valve *a* to be closed, thereby preventing any further increase of pressure in the brake-cylinder.

The foregoing described operation is the method by which this structure charges a limited amount of air pressure into the brake-cylinder.

520 X Q. Attached to the valve *a*, in the device of that patent, is a tapering extension or plug *o*; what is the object of that tapering plug, and what function does it perform in the structure?

A. The object of the piece in question is to form a guide or support for the pin *s*[1], and that is the function it performs.

521 X Q. The specification of that patent states as follows:

"The conical plug *o* is attached to the lower end of the stem *g* in such position as to enter the port *o*[1], which connects the chambers G[1] and H; but this plug *o* is of such shape as to graduate the size of the opening of the port *o*[1], accordingly as it is raised more or less by the upward movement of the stem *g*.

*　　*　　*　　*　　*　　*　　*

"By the use of the taper plug *o*, in the manner described and by regulating, as can easily be done by the use of suitable cocks, the amount of pressure in the upper and lower parts of the chamber G[1], it is easy to regulate the amount or density of the air which is permitted to flow through the port *o*[1] into the brake-cylinder, and consequently easy to regulate and adjust, at all times, the force with which the brakes are applied, and such force may be varied from the maximum power of the brakes down to the fractional part of a pound, in excess of ordinary atmospheric pressure."

This description describes the plug *o*, as the means by which the graduating function is performed, does it not?
483 A. No.

522 X Q. What does it describe, as you understand it?

A. It describes a construction of valve with the plug attachment, the plug being of such shape or form that the size of the port in which it is inserted will be varied as the valve is lifted a greater or less distance from its seat. It then states that

"By the use of the taper plug in the manner described *and by regulating, as can easily be done by the use of suitable cocks* the amount of pressure in the upper and lower part of the chamber G[1], it is easy to regulate the amount or density of the air which is permitted to flow through the port *o* into the brake-cylinder and consequently easy to regulate and adjust at all times, the force with which the

brakes are applied, and such force may be varied from the maximum power of the brakes down to the fractional part of a pound in excess of ordinary atmospheric pressure."

The only possible construction to be placed upon the matter quoted from the specification is, that by the use of the combination of the plug *o*, as shown in the patent, and by the regulation of pressures by means of suitable cocks, the amount or density of the air which is permitted to flow into the brake-cylinder is regulated.

As a matter of practical operation of the structure shown in the patent in question, the use of plug *o* for the purpose described in the parts of the specification which have been quoted, is entirely unnecessary.

523 X Q. In the matter above quoted by you, what do you understand by the expression "suitable cocks;" does that refer to the cock or valve generally known as the engineers' valve?

A. I presume it does.

524 X Q. As described in said patent 141,685, do the dia-
484 phragm *n* and valve *a*, have different degrees of upward movement, according as it may be intended by the engineer to apply the brakes with less or greater force?

A. I think the substance of some portions of the specification is to the general effect that, by a manipulation of the engineers' valve in a suitable manner, the diaphragm *n* and valve *a* could be moved a greater or less distance, for the purpose of admitting different degrees of pressure to the brake-cylinder.

525 X Q. Assuming that structure to be used on a train, and assuming the train-pipe to be accidentally ruptured, so as to release its pressure and apply the brakes automatically, would the diaphragm *n*, valve *a*, and plug *o*, move upward to the extreme limit of their movement in that direction?

A. They probably would.

526 X Q. And would such movement of said parts to the extreme limit in the upward direction open the port o^1 more fully than a shorter upward movement of said parts, for example, such an upward movement as would take place in admitting five pounds of air pressure from the auxiliary reservoir to the brake-cylinder, as stated by you in answer to X Q. 519?

A. Such upward movement of said parts would probably open the port o^1 more fully than a shorter movement, but such complete upward movement is frequently made, and can be readily made, when charging a limited amount of pressure into the brake-cylinder, as described by me in a former answer.

527 X Q. Is there any necessity for giving said parts their extreme upward movement in the act of attempting to apply the graduated pressure to the brakes?

A. It is frequently the most desirable mode of operation, and it is the necessary method for the purpose of stopping the train quickly by a graduated application of the brakes.

528 X Q. If I understand you, then, a skillful engineer, using the apparatus of patent 141,685, would, in case of a sudden emergency

requiring the application of the brakes with their full force,
485 in the shortest possible time, suddenly exhaust the train-pipe pressure, to such an extent as to force the diaphragm n, valve a, and tapering plug o, upward to the full extent of their movement in that direction, and thereby open the port o^1 to its full capacity; am I correct?

A. Yes.

529 X Q. Referring now to the patent of George Westinghouse, Jr., dated October 5, 1875, No. 168,359, please explain briefly the operation of the apparatus therein shown, in the act of making a graduated application of the brakes.

A. Assuming that the train pipe and auxiliary reservoir are charged with pressure of seventy pounds, and the triple-valve piston G and slide-valve H are in the position shown in figure 1, if it is desired to make a graduated application of the brakes, a reduction of pressure is made on the train-pipe side of the triple-valve piston G, such reduction being less than is required for a full application of the brakes. The higher auxiliary reservoir pressure will force the piston G in a downward direction, carrying with it valve H, until the end of valve H uncovers port e. Air will then flow directly from the auxiliary reservoir to the brake-cylinder.

In its downward movement for a sufficient distance to uncover port e, the piston G strikes the stem d^4 a little before the valve H uncovers port e, and thereafter, during the continuance of its stroke, it overcomes the resistance of the spring d^2. With the port e uncovered, the passage of air from the auxiliary reservoir to the brake-cylinder will reduce the pressure on the upper side of the piston G, until the combined effect of the higher train-pipe pressure and the compressed spring d^2 forces the valve H to the position where port e is entirely covered. Communication from the auxiliary reservoir to the brake-cylinder will be cut off, and a pressure less than the maximum pressure will have been charged into the brake-cylinder and retained there.

486 530 X Q. Explain briefly the operation of the same apparatus in making a full application of the brakes in the shortest possible time, as in case of an emergency.

A. The operation asked about is substantially the same as the one already described, except in respect to the amount of reduction of pressure in the train-pipe.

To make a full application of the brakes, it is necessary that the pressure on the under side of piston G shall be reduced sufficiently below the fully expanded auxiliary reservoir pressure, when it has passed into the brake-cylinder for a full application, to force the piston G in its complete downward position, and to overcome the resistance of spring d^2.

531 X Q. In that apparatus, when the piston G is forced downward to the full extent of its movement in that direction, its V-shaped projection v rests upon the rubber seat v^1, does it not?

A. Yes.

532 X Q. In making a full application of the brakes in the shortest possible time, as in the case of an emergency, with that appa-

ratus, the piston G is forced downward until it rests against the rubber v^1, is it not?

A. It generally is.

533 X Q. And that full movement of the piston G causes the valve H to open the port *e* wide open, does it not?

A. Yes, it does.

534 X Q. In making a graduating application with that apparatus, for example, in admitting ten pounds of air pressure into the brake-cylinder, how far would a skillful engineer ordinarily move the piston G downward, and to what extent would such movement uncover the port *e*?

A. If he desired to operate the brakes to the best advantage, he would manipulate the engineers' valve so as to produce a full movement of the piston G, and open the port *e* to its greatest extent.

487 535 X Q. In case he did do that, how many pounds pressure would he get in the brake-cylinder?

A. The amount of pressure charged into the brake-cylinder would depend entirely upon the length of time that the port *e* remained open.

The structure shown in patent 168,359 can be manipulated so as to open port *e* to its full capacity, and charge into the brake-cylinder the smallest amount of pressure required in a practical operation of brakes.

536 X Q. In the ordinary application of that apparatus by skilled engineers, for graduating purposes, where it was desired to apply the brakes slowly, with a light pressure, how was the apparatus operated? Was it operated to move the piston to its *full* stroke, so as to fully uncover the port *e*, or was it operated to move the piston a *partial* stroke, so as to only partially uncover the port *e*?

A. To apply the brakes both moderately and slowly, it is desirable to operate the triple valve in question so as to partially uncover the port *e*.

537 X Q. And to apply them quickly, with full force, it is desirable to operate the triple valve of that structure so as to fully uncover the port *e*, is it not?

A. To make a full application of the brakes, it is desirable that port *e* shall be fully and quickly uncovered.

538 X Q. That apparatus, then, was so organized, that, to apply the brakes slowly and moderately, the piston would ordinarily be moved through a portion of its full stroke, and partially uncover the port *e*, while to apply them quickly, with full force, the piston would be moved the entire length of its stroke, and fully uncover the port *e*; am I correct?

A. A single structure of this kind in use on a train would operate in the manner described, if it were desired to apply the brakes slowly and moderately in one instance, and with a full application in another.

When, however, structures of this kind are regularly used in practice, on trains of from five to fifteen cars, their operation is
488 somewhat different, as compared with the operation of a similar structure when used on a single car.

The maximum flow of pressure, and the rapidity with which brakes can be applied with full pressure, is dependent upon two conditions. The first condition is, that reduction of pressure in the train-pipe, and on the under side of piston G shall be rapidly made so that the piston G will quickly move to a position to allow air to flow from the auxiliary reservoir to the brake-cylinder.

The second condition is, that the passage leading from the auxiliary reservoir to the brake-cylinder should be large enough to permit the rapid flow of pressure from the auxiliary reservoir to the brake-cylinder, when such port is open.

If the reduction of train-pipe pressure is not rapidly and considerably made, then the travel of the triple-valve piston G will be sluggish, and the operation of the brakes correspondingly slow.

If, on the other hand, the communication between the auxiliary reservoir and the brake-cylinder is too much restricted, the passage of air into the brake-cylinder will be retarded, although the reduction of train-pipe pressure may have been great and rapid enough to have quickly opened such passage.

It will therefore be seen, that the arrangement and proportions of the relative parts of an automatic brake mechanism should be such that the passage leading from the auxiliary reservoir to the brake-cylinder should be of a size to permit the flow of air, from the auxiliary reservoir to the brake-cylinder, at a rate that will cause a fall of pressure in the auxiliary reservoir that is practically the same as the rate of reduction made in the train-pipe. If the passage leading from the auxiliary reservoir to the brake-cylinder were of a size that, when fully uncovered or opened, it would cause a reduction of pressure in the auxiliary reservoir more rapidly than it is possible to reduce pressure in the train-pipe, and train-pipe side of the triple
valve, then such proportioning of the passage would be ob-
489 viously unnecessary, as only so much of the passage leading
from the auxiliary reservoir to the brake-cylinder would be uncovered by the valve controlling such passage, as would be required to lower the pressure in the auxiliary reservoir, and on the upper side of the triple-valve piston, at the same rate that it is lowered on the under side, or train-pipe side, of the valve piston. For, if the passage leading from the auxiliary reservoir to the brake-cylinder should be opened wide enough to cause a greater reduction of pressure on the upper side of the triple-valve piston than is being made on the lower side, the higher pressure on the lower side would at once move the piston and valve in an upward direction, until the flow of pressure from the auxiliary reservoir to the brake-cylinder would be at a rate to practically establish an equilibrium of forces acting on the opposite sides of the triple-valve piston.

If, on the other hand, the passage from the auxiliary reservoir is too greatly restricted, with reference to the reduction of pressure on the train-pipe side of the triple-valve piston, then the complete and quick traverse of the piston, brought about by the rate of reduction of train-pipe pressure, will be less effective, in the quick and full application of the brakes, than would have been the case if the passage from the auxiliary reservoir were proportioned with respect to

the rate or fall of pressure on the train-pipe side of the triple-valve piston.

From the foregoing explanation, it will be seen that to secure a uniform and simultaneeus application of automatic brakes, on a train of cars fitted with the triple-valve structure of patent 168,359, it is essential that the reduction of pressure shall be made in the triple valve, at the same rate and at the same time; for the purpose of obtaining the results stated, these requirements are absolute, with the use of the construction in question.

In the practical operation of automatic brakes, the general
490 mode of causing them to apply, is for the engineer to manipulate a valve on the engine which opens communication between the train-pipe and the atmosphere. This opening causes a reduction of pressure in the train-pipe, which is made more rapidly at a point nearer to the valve operated by the engineer than it is in more remote parts of the train-pipe extending to the rear of the train. At the rear of the train, the reduction is at the slowest rate, and commences at the latest period after the opening of the engineers' valve. This method of application, as before stated, was the one generally used in applying automatic brakes. They would also be brought into action, and caused to apply, if the train-pipe were in any way ruptured or separated, so as to cause a considerable fall of pressure, and it was the general practice to place a valve in each car, that could be opened for the purpose of operating brakes, so far as their application was concerned, substantially in the same manner as by the use of the engineers' valve.

The length of time required to make the reduc of pressure in the train-pipe, when the reduction was made by the use of the engineers' valve, depended upon the length of the train, and some idea of the length of this time can be gathered from information obtained at the time of the Burlington brake trials, in which a train fitted with plain automatic triple valves was operated.

It was found that a period of thirteen seconds elapsed, after the opening of the train-pipe valve by the engineer, before any sensible reduction of pressure in the train-pipe took place in the fiftieth car. It was also found that, at a speed of twenty miles an hour, many of the brakes, on the rear portion of the train, did not commence to apply until the train had been entirely stopped by the application of brakes in the front portion of the train, brought about by the fact that these brakes were located relatively nearer to the point of greatest reduction in the train-pipe pressure.

The report of the Master Car Builders' committee stated,
491 in substance, that a train of fifty cars, fitted with the automatic brake apparatus in use at those trials, was stopped as quickly when but thirty of the brakes were in operation, the remaining twenty (on the rear portion of the train) being cut out of service. This was an obvious result, as no useful effect is produced by applying brakes to the train after motion has ceased.

It is therefore evident that one of the necessary conditions of prompt and uniform application of brakes on trains of more than one car, viz., a reduction of triple-valve pressure at the same time,

on all of the cars of the train, was not obtained to any practical extent by the reduction of train-pipe pressure at a single point in the train-pipe.

It was also found that the rate of reduction in pressure, in triple valves located in different portions of the train, was not the same, differing in about the same degree as the times of reductions of pressure differed.

The effect of the manner of operating these brakes was extremely objectionable, being dangerous to life and destructive to property, and the Master Car Builders' committee did not think it practical or safe to operate the train to carry out the intended experiments, with the apparatus as then organized. This objectionable and dangerous operation was the result of the application of brakes more rapidly and with greater force, on the front portion of the train, than on the rear portion, before the stopping of the train was entirely completed.

The more rapid application of the several brakes of the train, with respect to each other, brought about by the more rapid flow of pressure from the auxiliary reservoir in some instances than in others, was caused by the fact that the more rapid rate of reduction in the front portion of the train-pipe, as compared with the rear portion, caused the port leading from the auxiliary reservoir to the brake-cylinder to be opened to a greater extent in the triple valves in which the reduction of train-pipe pressure was more rapid, and this action greatly aggravated the objectionable results due
492 to the difference in times of application of the several brakes, with respect to each other, as the brakes in the front portion of the train were not only applied more promptly than those in the rear portion, but the brake force was admitted to the brake-cylinder more rapidly, on account of the larger opening for the passage of air pressure from the auxiliary reservoir to the brake-cylinder.

The objectionable feature of the more rapid flow of auxiliary reservoir pressure to the brake-cylinder, in the triple valves nearest the point of the greatest reduction of pressure in the train-pipe, could have been, in a measure, corrected by a proportioning of the passages leading from the auxiliary reservoir to the brake-cylinder, in such a manner that this passage, in the triple valves nearest the point of discharge of train-pipe air, would be comparatively small, even with a full traverse of the triple-valve piston, and each succeeding valve towards the rear of the train would require the proportioning of the passage leading from the auxiliary reservoir to the brake-cylinder, differing somewhat from every other valve, and dependent upon its location in the train, with respect to the point of greatest reduction of the train-pipe pressure in making an application of the brakes.

Such proportioning is obviously impracticable, on account of the necessary change of position of cars in trains, with relation to each other and to the point of application of brakes.

Another modification in the proportioning of the passage leading from the auxiliary reservoir to the brake-cylinder could have been made, that would have caused the operation of the brakes to have

been less dangerous and objectionable, in respect to the producing of shocks or internal collisions.

This modification would have been such a reduction in the size of the passage leading from the auxiliary reservoir to the brake-cylinder as would have caused the auxiliary reservoir pressure to pass to the brake-cylinder very slowly. This would have
493 resulted in an application of the brakes, so moderate as to have made the retardation of the front portion of the train but little greater than the rear portion, thus removing the cause of the dangerous and objectionable operation before referred to.

This modification, however, would also have resulted in defeating the principal object for which power brakes are put upon trains, namely, to stop them in a less distance than is required by hand brakes to do the same work.

A careful consideration of the facts I have stated will make it clear that the practical conditions of operation required that the proportions of the passages leading from the auxiliary reservoir to the brake cylinder should be of a size that will, in operation, result in the maximum of train-stopping effect, with a degree of shock or internal collision that does not exceed the reasonable capacity that car structures have for sustaining such shocks and strains, without undue cost of repairs and maintenance.

Referring to the structure of patent 168,359, it will be seen that the port *e* leading from the auxiliary reservoir to the brake-cylinder is of considerable size, and if triple valves of this kind were used in an automatic brake mechanism, on a train of several cars, under no probable conditions could all of them, or in fact any great number of them, in a train, say of twenty cars, be made to operate so as to cause the piston G to make its complete traverse, and fully open the port or passage *e*, before full auxiliary reservoir pressure had been charged into the brake-cylinder.

If train-pipe pressure is completely exhausted, or lowered a little below the expanded auxiliary reservoir pressure, the piston will ultimately complete its traverse, but such triple valves as are at all remote from the point of application will not make such complete traverse until the auxiliary reservoir pressure has been fully charged into the brake-cylinder.

In practical operation, the valve of structure of patent
494 168,359 would be entirely unsuitable for use on any but comparatively short trains, closely coupled, so that there would be but little lost motion between the several cars of the train.

Referring to patent 243,415 it will be observed that the passage of the triple-valve structure, leading from the auxiliary reservoir to the brake-cylinder is much smaller, relatively, than the same passage in triple valve of patent 168,359. The triple valves used in the Burlington tests referred to were substantially the same as that of patent 243,415, and the result of those experiments proves conclusively that the size of the passage in question was greater than could be safely used when these valves were used upon long trains.

Referring to that portion of the question which speaks of the

method of operating brakes "slowly and moderately," I am of the opinion that the attempt to operate the brakes in the manner described would not be very successfully accomplished, for the reason, that if a slow and moderate reduction of train-pipe pressure was made, the outflow of auxiliary reservoir air to the passage *s* would be such as to prevent the effecting of a sufficient difference of pressure between the auxiliary reservoir side and the train-pipe side of the triple-valve piston to overcome the friction of the slide-valve H.

In practice, it has been found necessary to make a considerable and quick reduction of pressure, in the first instance, for the purpose of definitely effecting the closure of port *s*, by the downward movement of the triple-valve piston *e*.

The above long and discursive answer, occupying the greater part of the day's session, is objected to by defendants' counsel, as irresponsive to the question.

539 X Q. You have testified that the triple valve of patent 168,359 was used for about two years, before it was superseded by
495 another form of triple value; was it used on passenger trains or freight trains?

A. Passenger trains.

540 X Q. What is the ordinary average number of cars employed in making up passenger trains?

A. I presume the average passenger trains consist of about eight cars, although, in some instances, as high as twelve or fifteen are regularly put on.

541 X Q. Is it your opinion that when Mr. George Westinghouse, Jr., in the specification of patent 168,359, directed the engineer to reduce the train-pipe pressure about fifteen pounds, in order to apply the brakes with full force, and to reduce the train-pipe pressure to a correspondingly less amount, in order to apply the brakes with less than the maximum power, he did not understand the operation of his own invention?

Objected to as incompetent.

A. I cannot quite see that the instructions quoted give sufficient information on which to base an opinion.

542 X Q. In what year were the Burlington trials to which you referred in your answer to X Q. 538?

A. In the year 1885.

543 X Q. Was the apparatus of patent No. 168,359 an automatic air-brake apparatus—that is to say, would it automatically apply the brakes with full pressure, as a consequence of the accidental rupture of the train-pipe?

A. Yes, it would apply under the conditions stated.

544 X Q. In thus automatically applying the brakes, on a passenger train of fifteen cars, and in consequence of the breaking apart of the train-pipe, would it move the piston G the full length of its stroke and open the port *c* wide open?

A. As stated in a previous answer, such operation would pre-

sumably always move the piston to its complete traverse and
496 fully open the port *e*, but, as also stated, such complete opening would, or would not, take place prior to the complete equalization of auxiliary reservoir and brake-cylinder pressures, depending upon the location of the triple valve in question, with respect to the point at which the pressure is discharged from the train-pipe. If full auxiliary reservoir pressure has been charged into the brake-cylinder by the partial traverse of the piston G, resulting in the partial opening of the port *e*, the further and complete traverse of the piston G, and the full opening of port *e*, will accomplish no practical results in the matter of the application of brakes.

While it is not stated at what point in a train of fifteen cars the supposed rupture of the train-pipe takes place, I will assume that it is practically in the middle of the train. Upon this assumption nearly all of the triple valves in the train would operate in a manner that would cause a full opening of the port *e*, before auxiliary reservoir air has been fully charged into the brake-cylinder.

In practical experiments, I have found that a train of seven cars is the greatest length of train in which a port of the size of the port *e* leading from the auxiliary reservoir to the brake-cylinder can be fully opened, before full auxiliary reservoir pressure has been charged into the brake-cylinder. Generally speaking, therefore, it may be stated that if a rupture of the train-pipe should take place at some other point than near the middle of the train, the triple valves on the rear portion of the train, having the greatest number of cars with an unbroken train-pipe, will not fully open the passage *e* until full auxiliary reservoir pressure has been charged into the brake-cylinder.

545 X Q. While that triple valve of patent 168,359 was in actual use on passenger trains during the two years referred to, do you remember of hearing any complaints about its causing the damaging or destructive shocks or internal collisions to which you have referred?

497 A. There were a great many complaints about damaging shocks, but as these triple valves were not used upon long trains, the complaints were not based upon such serious results as those that were produced at Burlington to which I have heretofore referred.

Adjourned to Monday, December 18, 1893, at 10 a. m.

New York, *December* 18, 1893—10 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of H. H. Westinghouse resumed:

546 X Q. The triple valve of patent 168,359 was entirely practical for passenger trains, was it not?

A. It was considered so at the time it was used, that being the best appliance of the kind in the art.

547 X Q. So far as you know, it never seriously damaged or injured any of the passenger cars by reason of the shock, did it?

A. Not that I am aware of, although, owing to its peculiar construction, very objectionable results were produced in the matter of discomfort to passengers, when the trains were of any considerable length.

548 X Q. Referring now to the patent of George Westinghouse, Jr., No. 172,064, dated January 11, 1876, please state in what, if any, material respect, the structure there shown differed from that of patent 168,359, and what advance in the art was first found in patent 172,064?

A. Referring to the construction shown in patent 168,359, it will be observed, that the slide-valve H is attached to the stem of the piston G, in a manner that requires the valve to be moved whenever the piston G moves. That is to say, the pistion G practically has no movement independent of the slide-valve H.

498 It will also be seen, in the illustration referred to, that when the parts of the triple valve are in the position shown, the port *s*, for admitting air from the train-pipe to the auxiliary reservoir, is opened by the complete upward traverse of the piston G.

To cause the triple-valve piston G to move in a downward direction for the purpose of applying brakes, it is necessary that the pressure on the lower or train-pipe side of piston G should be reduced below the pressure on the upper or auxiliary reservoir side of the piston G, and the amount of this reduction should be sufficiently great to overcome the friction of the piston G and slide-valve H.

On account of the considerable degree of friction in slide-valve H, a considerably greater reduction of pressure, relatively, was required to move the piston and slide-valve H combined, than to move the piston alone.

The failure of the engineer to make a proper reduction to overcome the resistance of the slide-valve and piston would result in the failure to close port *s* by the downward movement of the piston G, and such operation would not apply the brakes, and would also lower the pressure in the auxiliary reservoir without performing useful work.

Referring to patent 172,064, it will be seen that the principal structural difference, as compared with the device of patent 168,359, is a limited amount of independent movement of the triple-valve piston relative to the slide-valve.

This free movement of the triple-valve piston is of a degree that enables it to move downward, a sufficient distance to close the port connecting the train-pipe side of the triple-valve piston with the auxiliary reservoir side.

The amount of reduction of pressure on the train-pipe side of the triple-valve piston necessary to cause the piston to move and close the charging port is only that required to overcome the friction of the triple-valve piston alone, while, as already explained, in

499 the device of patent 168,359 a reduction of pressure great enough to overcome the resistance of the slide-valve and triple-valve piston combined was required.

By this improvement, the possibility of depleting the auxiliary reservoir, without applying the brakes, was greatly reduced.

549 X Q. Except in respect to the "lost motion" permitted by the construction shown in patent 172,064, the triple valve of the latter patent operated substantially the same as the triple valve of patent 168,359, did it not?

A. Except in respect to the said lost motion, and the result produced thereby, it did.

550 X Q. Briefly explain why it is that, in triple valves, the slide-valve corresponding to valve H of patents 168,359 and 172,064, is subjected to considerable friction during the movement of the piston G?

A. The friction of the valves referred to is principally caused by the absence of any but atmospheric pressure in the exhaust cavity, while there is usually a pressure of from fifty to seventy pounds on the back or the inner side of the valve. This pressure forces the surfaces of the slide-valve and the triple-valve casing in contact with each other with considerable force, and produces the friction referred to.

551 X Q. Please explain the material difference between the triple valve of patent 220,556 and the triple valve of patent 172,064, and state what substantial advance in the art was first shown in the triple valve of patent 220,556.

A. In the triple valve of patent 172,064, as previously explained, to cause the piston in the slide-valve to move in a downward direction for the purpose of opening communication between the auxiliary reservoir and the brake-cylinder, it was necessary to produce a sufficient difference of pressure between the train-pipe side of the piston and the auxiliary reservoir side to overcome the resistance of the friction of the piston and the slide-valve. The amount of this friction was considerable, and the difference of pressure on
500 the opposite sides of the triple-valve piston was proportionate to the resistance.

The principal objectionable result of the condition stated, existed in making graduated applications of the brakes, which may be explained somewhat as follows:

If a reduction of pressure of ten pounds were made on the train-pipe side of the triple-valve piston, and it required a reduction of two pounds to overcome the friction of the piston and slide-valve, the ten pounds reduction would then be sufficient to overcome this resistance, and move the triple-valve piston and slide-valve so that pressure would be admitted from the auxiliary reservoir to the brake-cylinder.

As the friction of the slide-valve and piston are practically the same when in position for admitting pressure from the auxiliary reservoir to the brake-cylinder, and as it is necessary that the pressure on the auxiliary reservoir side of the triple-valve piston should be lowered sufficiently to enable the pressure on the train-pipe side to move the piston and slide-valve to a position that will cut off communication between the auxiliary reservoir and the brake-cylinder, it is evident that the cutting off of this communication

will not take place until a difference of pressure on the opposite sides of the piston of two pounds is produced by the flow of pressure from the auxiliary reservoir to the brake-cylinder, because it has already been assumed that this difference of pressure is required to overcome the frictional resistance of the piston and slide-valve, whenever it is desired to move them.

The result of this operation is, that instead of charging ten pounds of auxiliary-reservoir air into the brake-cylinder, twelve pounds would have entered, before communication between the auxiliary reservoir and brake-cylinder has been cut off.

Described in general terms, the effect of this friction is to prevent the admission of auxiliary-reservoir pressure to the brake-cylinder, in the limited quantities found to be desirable in the practical operation of triple valves.

501 Referring to the construction of patent 220,556, it will be noted that, combined with the slide-valve H, there is a supplementary valve e^1, which controls a port marked s^1.

The movement of valve e^1 is the same in extent, and is brought about by the independent motion of the triple-valve piston, as compared with the slide-valve H. Assuming the structure to be in the position shown in figure 1 of the patent in question, a reduction of pressure on the train-pipe side of the triple-valve piston will cause the piston to move in a downward direction, carrying with it the valve e^1, by means of pin e^3, thus moving it from its seat e, but such movement will effect no result, in the application of brakes, until the port s^1 registers with the port C.

Assuming that the reduction made on the train-pipe side of the triple-valve piston, for the purpose of an application of the brakes with a limited pressure, and assuming, as in the previous instance, a reduction of ten pounds in the train-pipe, auxiliary reservoir pressure will flow into the brake-cylinder, through the port s, until the difference of pressure between the auxiliary reservoir and the train-pipe side of the triple-valve piston shall be such that the higher pressure on the train-pipe side of the piston will move it in an upward direction until valve e^1 is seated, and communication cut off between the auxiliary reservoir and the brake-cylinder.

The construction shown in patent 220,556 requires, for the purpose of cutting off communication between the auxiliary reservoir and the brake-cylinder, that the differences of pressure on the opposite sides of the triple-valve piston shall be only such as to overcome the resistance of the triple-valve piston alone, the valve e^1 having practically no frictional or other resistance.

The principal improvement in this structure, as compared with the one shown in patent 172,064, is its capacity for charging
502 limited amounts of pressure into the brake-cylinder, for making graduated applications of the brakes.

552 X Q. The amount or degree of reduction of train-pipe pressure requisite to move the slide-valve H, so as to cut off communication between the brake-cylinder and the atmosphere, preliminarily to the introduction of auxiliary reservoir pressure into the brake-cylin-

der, is substantially the same with the triple valves of all three of said patents, Nos. 168,359, 172,064 and 220,556, is it not?

A. Assuming that the relative proportions of the various parts and passages are the same, my answer is yes.

553 X Q. But, with the triple valves of patent 220,556, after the admission of auxiliary reservoir pressure into the brake-cylinder once begins, it will be stopped earlier than with the triple valves of patents 168,359, 172,064, because it requires a less diminution of pressure on the auxiliary reservoir side of the piston G, to move such piston G upward, and seat the valve e^1, in the structure of patent 220,556, than it requires, in the structures of the said other two patents, to move both the piston G and the slide-valve H upward, to close communication between the auxiliary reservoir and the brake-cylinder; am I correct?

A. Assuming that the graduated application is made through the port s^1, I believe your statement is correct.

554 X Q. In the structure of patent 220,556, the port s^1 is the port through which the graduated application of the brakes was intended to be made, is it not?

A. I should suppose it was, as it is the best adapted for that purpose.

555 X Q. There is a port s^2 shown in figures 1, 4 of the drawings of patent 220,556; has that port been generally retained and used, in the triple valves made by the Westinghouse Air Brake Company since the date of that patent?

A. It has not.

556 X Q. Assuming the triple valve of patent 220,556 to
503 be used on a train of cars, and assuming that, by the rupture or parting of the train-pipe, a sudden and considerable reduction of train-pipe air pressure takes place, state what movement of the piston G and slide-valve H would thereby be effected?

A. Assuming a train of fifteen cars, as in a previous answer, and assuming that the rupture of the train-pipe was near the middle of the train, the operation of the valves on the train, if of the kind shown in patent 220,556, will be somewhat as follows:

The first two or three valves in each portion of the train nearest the rupture in the train-pipe, would have a complete triple-valve piston movement, causing the slide-valve H to move to its lowest position, thus fully uncovering port C.

The succeeding valves of the train would probably stop at a point where the port s^1 would open communication between the auxiliary reservoir and the brake-cylinder, and remain in that position for a longer or shorter period, dependent upon their location with reference to the rupture in the train-pipe.

Under all of the conditions stated, it is probable that the pistons of all of these triple valves would move to the position of complete opening of port C, before all of the auxiliary reservoir pressure was charged into the brake-cylinder through the port s^1, but the amount of pressure charged into the brake-cylinder, by the full opening of port C, would rapidly decrease towards the end of the train, and I should say that all but from five to ten pounds would have been

admitted to the brake-cylinder before the port C is fully uncovered by the complete downward movement of the triple-valve piston.

With a greater number of cars, the mode of action described is such as to cause the additional size of the port C, as compared with the port s^1, to produce no practical effect in more quickly charging auxiliary reservoir pressure into the brake-cylinder.

It may also be stated, that in general practice, there is
504 usually nothing requiring the full and more prompt application of brakes, by the rupture of the train-pipe, than under many other conditions, the principal requirement, under such conditions, being that (if the rupture of the train-pipe is caused by a separation of the train) both parts of the train shall be stopped without again coming together or uniting with destructive effect.

557 X Q. In your last answer you state "that in general prac there is usually nothing requiring the full and more prompt ap cation of brakes, by the rupture of the train-pipe, than under a. y other conditions;" state what "other conditions" you refer to.

A. Under the conditions of impending disaster in the form of collisions, open draw-bridges, and other defects of the track or obstructions upon the track, or any other condition in which the distance that can be run without encountering accidents, is limited, it is of the highest importance that the brakes should be applied as quickly as possible. The conditions under which the rupture of train-pipes usually take place are such as to make the most important consideration the one previously stated, as there is usually no other circumstances connected with the accident of train-pipe rupture to call for an unusually quick application of the brakes.

558 X Q. In the last part of your answer you refer to the necessity of preventing the two separated portions of the train from coming together in collision, do you?

A. I do, yes.

559 X Q. The conditions of impending disaster or extreme danger referred to in the first part of your answer to X Q. 557 are the conditions to which the name "emergency" is usually applied, are they not?

A. I should say they would be correctly described as emergency conditions.

560 X Q. Does the triple valve of patent 220,556 belong to the class of so-called "automatic" air brakes?

A. It is a part of an automatic air-brake system.

505 561 X Q. The feature of employing a slide-valve, which was introduced by the use of the slide-valve H in patent 168,359, has been adhered to by the Westinghouse Air Brake Company in the construction of its triple valves ever since the date of that patent, has it not?

A. In general practice it has; experimentally other kinds of valves have been used.

562 X Q. The feature of giving said slide-valve a lost motion or giving the piston a lost motion with respect to the slide-valve, first introduced in patent 172,064, has been retained and employed by

the Westinghouse Air Brake Company, in substantially all of its triple valves, ever since the date of the patent 172,064, has it not?

A. It has.

563 X Q. The feature of employing the small auxiliary valve or plug valve marked e^1 in patent 220,556, in addition to the slide-valve, has been retained and employed by said company, in substantially all of its triple valves made since the date of patent 220,556, has it not?

A. It has.

564 X Q. You have heretofore testified that, during the latter part of 1886 or the early part of 1887, the form of triple valve shown in patent 360,070 was, for the purposes of freight-car service, superseded by the form of triple valve shown in patent 376,837; how long did the last-mentioned form of triple valve remain the standard form of the Westinghouse Air Brake Company?

A. It has remained the standard up to the present time.

565 X Q. Assuming a train of six or eight passenger cars, equipped with the triple valves of patent 220,556 to be running swiftly on the railroad, when suddenly the engineer discovers an open bridge, two or three hundred feet ahead of the engine; how would it be his duty to apply the brake apparatus in such case, and, when so applied, what would be the movement of the triple-valve pistons and valve H?

506 A. Under the conditions specified, the engineer would open the application valve to its greatest extent, and release the train-pipe pressure as rapidly as possible, which would probably result in the complete traverse of the triple-valve pistons of the triple valves in the front portion of the train, which would fully open the port C, while the pistons of the triple valves of the cars on the rear portion of the train would first move to a position that would bring the port s^1 into communication with the port C, admitting auxiliary reservoir pressure to the brake-cylinder through the port s^1. If the accident of running into the draw-bridge, which would probably take place under the conditions named, did not interfere with the further operation of the triple-valve structures, the pistons of all the triple valves would finally make their complete traverse, and fully open the port C, although, upon the cars of the rear portion of the train, the larger part of the braking would have been done by the admission of auxiliary reservoir pressure through the port s^1.

566 X Q. In the operation of a triple valve like that shown in patent 220,556, at the normal air pressure with which such air-brake apparatus is usually charged, how much more rapidly would the air pressure flow from the auxiliary reservoir into the brake-cylinder when the triple valve was so operated as to suddenly open the passage C wide open, than would be the case when the triple valve was so operated as to put only the port s^1 into communication with the passage C?

A. I cannot definitely state what the difference in time would be, but, assuming one port to be fully opened in one instance, and the other to be fully opened in another, I should suppose the difference

in time required to charge full auxiliary reservoir pressure into the brake-cylinder would be less than one second.

567 X Q. The rapidity with which, under the several conditions stated, the air would flow from the auxiliary reservoir to the brake-cylinder, through said ports C, s^1, respectively, would be in direct proportion to the cross-sectional areas of the two passages C, s^1, would it not?

507 I do not know whether the times of application, when made through the two different-sized passages, would bear the same relation to each other as the areas of their cross-section, as I have never made a practical experiment directly in the line that would enable me to be accurately informed on that point.

568 X Q. That does not quite answer my question, which related to the comparative rapidity of the flow through said ports respectively, that is to say, to the comparative amounts of air that would flow through them in any given time, rather than to the question of the time in which the brakes would be applied. With this understanding, please answer the question again.

A. I do not know whether the rapidity of flow through the passages in question, and under the conditions that they are used, would be in direct proportion to their cross-section. This was substantially the meaning I intended to convey in my previous answer.

569 X Q. Is it true that air under pressure, in traversing a passage, is obstructed by sharp turns or right angles in such passage, so as to flow less freely or rapidly through the passage than it would flow if the passage were straight?

A. It depends largely upon the rate of flow.

570 X Q. Do you mean that it depends largely upon the pressure under which the flow takes place—I ask this question because the "rate of flow" is the very thing I am trying to get at. In answering this question again, as thus explained, you may assume that the passage is charged to its full capacity.

A. Under the conditions, as I understand them to be stated, the presence of angles or sharp bends interferes with the flow of air.

571 X Q. In the triple valves of patent 220,556, auxiliary reservoir air, passing to the brake-cylinder through the graduating passage c^2, c, s^1, C, would have to turn its course at right angles twice during its passage, namely, first, in passing from c^2 to c, and, secondly, in passing from c to s^1, would it not?

A. Such portion of the air as enters by port c^2 would have the course described in the question.

508 572 X Q. In case the piston G were moved through its entire traverse, so as to open the passage C wide open, the auxiliary reservoir air would pass directly from the port R to the port C, without being obliged to turn any corners or right angles, would it not?

A. It would.

573 X Q. Do you remember what was the length of the full traverse of the triple-valve piston G, in the triple valves made by the Westinghouse Company under patent 220,556?

A. I do not remember what its travel was, but I should think it was about one and an eighth inches.

574 X Q. Answer the same question as to the length of the traverse of the triple-valve piston 12, in the triple valves made by the Westinghouse Company under and in accordance with patent No. 360,070?

A. I should think the total travel of the piston of the device of patent 360,070 is about one inch.

575 X Q. Do you know what the total length of traverse of the triple-valve piston is in the defendants' triple valves such as are shown in plate IX (1889 catalogue) and plate XI (1891 catalogue)?

A. I do not.

576 X Q How long have you been familiar with the invention disclosed in patent 360,070?

A. I first knew of it a few months after its invention in 1886, and have known of it ever since.

577 X Q. In drawing No. 5 of Defendants' Exhibit Illustrative Cuts, does not the red line correctly show how the air moves from the auxiliary reservoir to the brake-cylinder, when the triple valve is in the position there illustrated?

A. It does.

578 X Q. In the experiments referred to by you in your answer to Q. 435, did you at any time lift the valve 22 (15) from its seat, without admitting the direct flow of air from the train-pipe to the brake-cylinder?

A. In none of the experiments that I conducted was I able to operate the defendants' valves to admit auxiliary reservoir
509 air to the brake-cylinder, through valve 22 (15), without also admitting train-pipe pressure. After full auxiliary reservoir pressure was charged into the brake-cylinder, the furthur traverse of the triple-valve piston lifted valve 22 (15) from its seat, but as full auxiliary reservoir pressure was already in the brake-cylinder, no further flow took place upon the opening of valve 22 (15).

579 X Q. In drawing No. 6 of Defendants' Exhibit Illustrative Cuts, does not the red line correctly show how the air moves from the auxiliary reservoir to the brake-cylinder, when the triple valve is in the position there illustrated?

A. In practical operation, the only time in which air from the auxiliary reservoir can take the course indicated by the red line is when air is also entering, or has entered, from the train-pipe.

580 X Q. Having answered a question that I did *not* ask you, will you now please answer the question that I *did* ask you?

A. In drawing No. 6 the red line correctly shows how the air moves from the auxiliary reservoir when the triple valve is performing a quick application, that is to say, when train-pipe air is being, or has been, admitted to the brake-cylinder.

581 X Q. And, under such conditions, the auxiliary reservoir air passes to the brake-cylinder through the port controlled by the valve 22 (15), does it not?

A. Yes.

582 X Q. One of the functions of the plain triple valves known

in the art prior to 1887 was to control the admission of auxiliary reservoir air to the brake-cylinder, was it not?

A. It was.

583 X Q. In the patent in suit, No. 360,070, does the valve 41 control the admission of air from the auxiliary reservoir to the brake-cylinder?

A. It does not.

584 X Q. In that respect, then, the valve 41 of the patent in suit differs in function from the valve 22 (15) of the defendants'
510 apparatus, which does control the admission of air from the auxiliary reservoir to the brake-cylinder; am I not correct?

Objected to for the reason that the question is based upon an allegation of defendants' counsel which makes him a witness in the cause, to wit, that the valve 22 (15) of the defendants' apparatus *does* control the admission of air from the auxiliary reservoir to the brake-cylinder.

The objection objected to, as an attempt to instruct the witness how to answer.

A. I do not consider that the valve 41 of patent 360,070 differs in function from valve 22 (15) of defendants' apparatus. In both structures, the valves referred to perform useful functions only when train-pipe pressure is being admitted directly to the brake-cylinder. In the defendants' structures, as previously stated, auxiliary reservoir air passes through the port of valve 22 (15) when, or subsequent to when, train pipe air has also passed through the same port, and I do not consider that the port or valve 22 (15) controls the flow of pressure from the auxiliary reservoir to the brake-cylinder, for the reason that communication is first made between the auxiliary reservoir and the brake-cylinder by the opening of valve port *i* (40), and if valve 22 (15) were not opened, and valve port *i* (40) were opened, then communication would still be open between the auxiliary reservoir and the brake-cylinder. If, however, the valve port *i* (40) were closed, then communication between the auxiliary reservoir and brake-cylinder would be entirely cut off, and, for this reason, I regard the valve port *i* (40) as controlling communication between the auxiliary reservoir and the brake-cylinder, and not the valve 22 (15).

584 X Q. You have testified that, under certain conditions, in the defendants' apparatus, air passes from the auxiliary reservoir
511 to the brake-cylinder through the port controlled by the valve 22 (15). You have also testified that under no conditions does air pass from the auxiliary reservoir to the brake-cylinder, in the apparatus of patent 360,070, through the port controlled by the valve 41. It appears, therefore, that, under a given condition, auxiliary reservoir air passes to the brake-cylinder through the port controlled by the valve 22 (15), while, in the other apparatus, under the same conditions, it does not pass through the port controlled by the valve 41. In that respect, then, the valves 41 of the patent in suit and 22 (15) of the defendants' apparatus differ in function, do they not?

A. The facts with respect to the passage of air in the structures in question, are stated correctly in substance in the question, but I do not think that the valves 41 and 22 (15) differ in function, because neither of these valves controls the flow of auxiliary reservoir pressure to the brake-cylinder.

585 X Q. The valve 22 (15) of defendants' apparatus controls the flow of auxiliary reservoir air *through its own port* to the brake-cylinder, does it not?

A. In the sense that when the valve 22 (15) is opened, and auxiliary reservoir pressure is flowing through its port into the brake-cylinder, and when it is closed and air is not flowing from the auxiliary reservoir into the brake cylinder through its port, the valve 22 (15) controls its port or passage.

586 X Q. You mean that when valve 22 (15) is opened, air flows through its port from the auxiliary reservoir to the brake-cylinder, and when said valve is not opened, air does not flow through its port from the auxiliary reservoir to the brake-cylinder, do you?

A. That was not the exact meaning I intended to convey, for, as a matter of fact, it is only under conditions previously stated that air ever flows from the auxiliary reservoir to the brake-cylinder through the port controlled by the valve 22 (15).

Adjourned to Tuesday, December 19, 1893, at 10 a. m.

512 NEW YORK, *December* 19, 1893—10 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of H. H. WESTINGHOUSE resumed:

587 X Q. When the air pressure in the auxiliary reservoir is higher than the air pressure in the brake-cylinder, in the defendants' apparatus, the valve 22 (15), if opened, allows the auxiliary reservoir air to pass through its port into the brake-cylinder, and, if closed, prevents any air from passing through its port into the brake-cylinder, does it not?

A. It does.

588 X Q. Under the same circumstances, in the apparatus of patent 360,070, the valve 41, if opened, does not allow auxiliary reservoir air to pass through its port to the brake-cylinder, and exercises no control over the passage of auxiliary reservoir air to the brake-cylinder: am I not correct?

A. Your statement of facts seems to me to be correct, but, as in X Q. 587, when referring to the passage of auxiliary air through the port controlled by valve 22 (15), it was not stated that the passage of air from the auxiliary reservoir to the brake-cylinder was controlled by valve 22 (15), I do not wish this answer to be construed as expressing the opinion that valve 22 (15) in defendants' apparatus controls the flow of pressure from the auxiliary reservoir to the brake-cylinder, in any practically operative sense, to any greater extent than the same function is performed by valve 41 in the structure of patent 360,070.

All of the above answer after the words "Your statement of facts seems to be correct," objected to by defendants' counsel as not responsive, but volunteered and argumentative.

589 X Q. Valve 22 (15) controls the flow of auxiliary reservoir pressure through its own port, does it not?

513 A. I do not think it does, for if it did control the flow of auxiliary reservoir pressure to the brake-cylinder through its own port, then it should have the capacity of limiting the flow, if it were desired to reduce the flow of pressure below the maximum rate. In practical operation this valve has only two positions. It is either held to its seat, so that there is no passage of air through its port, or else it is completely removed from its seat, so that the flow of auxiliary reservoir pressure, whenever such flow takes place through the port controlled by valve 22 (15), is controlled by the size of port B (*e*), which is much smaller than the port controlled by valve 22 (15).

I think my understanding of the question of control of auxiliary reservoir pressure, in the defendants' valves, can be explained by an illustration.

The ports controlled by valve 22 (15) and valve port *i* can be compared to the construction of doors sometimes found in establishments for manufacturing large and heavy machinery. In the construction of these doors, it is quite common to find the larger door having within it a smaller one, the smaller one being of a size suitable for the use of workmen to pass in and out of the building, and the larger one to be opened and to be used for the taking out of large machinery that could not be passed through the opening controlled by the smaller door. In such construction, whenever the larger door is opened, the smaller door necessarily goes with it.

Under the described conditions, I regard the smaller door as the one which controls the passage in the manufactory through which the workmen pass in and out of the building, and the larger as controlling the passage through which large and heavy machinery is taken in and out of the building. The fact that the larger door is closed, in no way affects the capacity of the smaller door to perform the function of admitting the workmen, and the opening of the larger door does not facilitate their going in and out, and is only useful for the purpose of admitting machinery that could not
514 be taken in through an opening of the size of the smaller door, and which is intended principally for the passage of workmen.

It seems to me that these conditions substantially exist in defendants' structure, with reference to the control of the passage of auxiliary reservoir air to the brake-cylinder. The valve port *i* admits auxiliary reservoir pressure to the brake-cylinder, in the degree and in the manner essential in structures of this kind, and it can be admitted through this port, or its flow to the brake-cylinder can be cut off, without moving, or in any way operating, valve 22 (15).

By the opening of valve 22 (15), which corresponds to the opening of the large door, the admission of train-pipe pressure is rendered

possible, which is an operation that could not be in any way affected by the opening of valve port *i*. The opening of valve 22 (15) practically carries with it the opening of valve port *i*, the same as the opening of the large door practically carries with it the small door, and the opening it controls, so far as any useful effect is concerned. When the valve 22 (15) is opened, and the auxiliary reservoir pressure is higher than the train-pipe pressure, it necessarily flows through the port opened by valve 22 (15), but the port 22 (15) has no control or limiting effect upon the flow of auxiliary reservoir pressure, because the passages leading from the auxiliary reservoir to the port controlled by valve 22 (15) are less in size than the port 22 (15). In the same way, the opening of the large door does not in any way facilitate the passage of the workmen in and out of the building, as compared with the opening of the small door alone.

This explanation, I think, will make clear my views upon the question of control of the flow of auxiliary reservoir pressure to the brake-cylinder in the defendants' apparatus.

590 X Q. Whether or not the opening of the port 22 (15) has a "*limiting* effect" upon the flow of auxiliary reservoir pressure
515 to the brake-cylinder, it does, when opened, have an *enlarging* effect upon such flow, does it not?

A. From an examination of the drawing of the structure as shown in defendants' 1891 catalogue, I should suppose it did have the effect described, as the valve port *i* is represented as smaller than the valve port B. In the structure shown in the drawing of defendants' 1889 catalogue, I do not think it has this effect, as the port controlled by valve 13 is represented as being larger than the port *e*, and no greater flow of pressure could be accomplished by the opening of valve 22 (15).

Whatever may be the fact with respect to the particular sizes of these ports, with relation to each other, in the drawings referred to, in practical operation, there is no reason why the ports controlled by the graduating valves should not be of the same size, or a little larger than the ports B (*e*). I have made a valve like defendants' structure, in which the graduating passages were enlarged until their capacity was considerably in excess of the ports B (*e*), and this structure, seemed to perform, in every respect, substantially the same as the defendants' apparatus, as usually made by them in regular practice.

591 X Q. In the defendants' structure, the valve 22 (15) has the capacity to admit auxiliary reservoir air to flow through its port to the brake-cylinder, when said valve is opened and the reservoir pressure is higher than the cylinder pressure, has it not?

A. As already stated, auxiliary reservoir air does flow through the port controlled by valve 22 (15), under the conditions stated, and, if there were no other passage through which auxiliary reservoir air could enter the brake-cylinder, it would then seem to me to have the capacity stated, but I do not think, as the defendants' structure is now organized, that the valve 22 (15) can be said to have that capacity.

592 X Q. In other words, if I understand you correctly, your

516 meaning is this: That although the valve 22 (15), under the conditions stated, does actually *admit* auxiliary reservoir air to pass through its port to the brake-cylinder, yet it does not have the *capacity* of admitting air to pass from the auxiliary reservoir to the brake-cylinder, because the same kind of air is at the same time passing through some other port to the brake-cylinder; do I understand you correctly?

A. I do not think I correctly understood X Q. 591, as, under the conditions stated therein, valve 22 (15) has the capacity of opening and permitting auxiliary reservoir pressure to flow through it to the brake-cylinder.

593 X Q. You have heretofore defined the word "function" as meaning "capability," when applied to mechanical structures; under that definition, then, the valve 22 (15), under the conditions stated in X Q. 591, performs the "function" of admitting auxiliary reservoir air to flow through its own port to the brake-cylinder, does it not?

A. If the flow of auxiliary reservoir air through the port 22 (15) is described as a function, then the valve 22 (15) does control that function of its port.

594 X Q. The valve 22 (15) has the "capability" or "function" of opening its port under certain conditions of use, and thereby admitting air to flow from the auxiliary reservoir to the brake-cylinder through the port which it thus opens, has it not?

A. Yes.

595 X Q. Let us now turn our attention to the valve or valve port *i* (40). I understand you to say that in the defendants' apparatus the port *i* (40) is opened for the admission of auxiliary reservoir air to the brake-cylinder at the same time that the port controlled by the valve 22 (15) is opened; am I correct in this?

A. Yes.

596 X Q. It is also true, is it not, that when both of said ports are opened, air from the train-pipe, as well as air from the auxiliary reservoir, will pass through the port *i* (40)?

A. Yes.

517 597 X Q. In the apparatus of the patent in suit, No. 360,070, when the port 42 has been opened by the valve 41, and the port 22 has been opened by the valve port 35, is it true that air from the train-pipe, as well as air from the auxiliary reservoir, will pass through the port 35 and port 22?

A. No.

598 X Q. In defendants' apparatus, for example, as illustrated by plate XI (1891 catalogue), assume the bushing 9 to be wholly removed, but the apparatus not changed in other respects, and state what, if any, material differences there would be between the practical operation of such apparatus and the practical operation of the apparatus shown and described in the patent of Mr. George Westinghouse, Jr., dated October 14, 1879, No. 220,556?

A. In respect to the application of brakes, the two structures would operate in much the same manner, but the defendants' structure would require a considerable modification to enable it to perform

all of the functions of the device of patent 220,556, as well as they were performed by that device.

599 X Q. What functions would it not perform as well, and why?

A. It would not perform the operation of releasing the pressure from the brake-cylinder to the atmosphere, on a train of any considerable length, in a satisfactory manner, as the feeding-in passage, for controlling the flow of pressure from the train-pipe to the auxiliary reservoir, is not properly restricted.

600 X Q. It is restricted just as much in that device, with the bushing 9 removed, as it is in the same device with the bushing 9 in place, is it?

A. No, for with the bushing 9 in place, the flow of pressure from the train-pipe to the auxiliary reservoir is controlled by the size of port B, but when bushing 9 is removed, it is controlled by the size of port A which is much larger than port B.

601 X Q. As to everything except the release of the brakes, the defendants' apparatus, when modified by omitting the bush-
518 ing 9, will operate substantially like the device of patent 220,556, if I understand you correctly; am I right?

A. In a general way, it would so operate.

602 X Q. Assume the defendants' apparatus with bushing 9 removed and port *i* (40) plugged, and state how the action of such apparatus, in practical use, would then compare with the action of the apparatus shown and described in the patent of George Westinghouse, Jr., dated January 11, 1876, No. 172,064.

A. The operation of the structure described would probably be somewhat less sensitive, in the matter of graduation, than the structure of patent 172,064, and, in a train of considerable length, as, for instance, one of twelve or fifteen cars, the application of brakes, in fully applying them, would be more uneven, that is to say, those upon the front portion of the train would be applied more quickly, relatively to those upon the rear of the train, as compared with a similar operation performed by the structure of patent 172,064.

These differences would exist, on account of the different forms of valve structure used to control the passage between the auxiliary reservoir and the brake-cylinder.

The proportioning of the ports and passages in the defendants' structure, when used in the manner described, is not of a kind to give the best results, were it to be used as modified.

603 X Q. The difference in sensitiveness to which you refer, results from using the plug form of valve 22 (15), instead of the slide form of the valve shown in patent 172,064, does it not?

A. This difference is not necessarily on account of the different forms of valves used, but on account of the proportions of these valves in the structures used.

604 X Q. The general mode of operation of the defendants' device, modified as stated in X Q. 602, would be the same, or substantially the same, as that of the device of patent 172,064, would it not?

A. It would.

605 X Q. And if we take the defendants' device, remove
519 the bushing 9, but leave the port *i* (40) not plugged, the gen-

eral mode of operation of such device would be the same, or substantially the same, as that of patent 220,556, would it not?

A. I think my answer to X Q. 601 will answer this.

606 X Q. With the defendants' apparatus modified as stated in X Q. 602, that is to say, by removing the bushing 9 and plugging the port *i* (40), under which conditions it would have the same general mode of operation as the triple valve of patent 172,064, as you have testified, what part of the defendants' modified triple valve structure would correspond to, and perform the functions of, the valve H of patent 172,064?

A. The valve 22, with the stem 18 and the release valve 17, would correspond to slide-valve H of the structure of patent 172,064.

607 X Q. Assume the triple valve of patent 220,556 to be used on a train of five or six passenger cars, and assume that, by reason of an impending emergency, the engineer should open the engineers' valve wide open, and suddenly reduce the pressure in the train-pipe, so as to bring the pistons G to the full limit of their traverse, in such case the port s^1 would move past the port C very quickly, and but a small amount of auxiliary reservoir air would pass through the port s^1 into the brake-cylinder; am I not correct?

A. I think with the train of the length stated, the operation of the valves would be substantially as described in the question, although it is possible that, on the last one or two cars, the admission of air through port s^1 might be considerable in amount, before the complete traverse of the triple-valve pistons was made.

608 X Q. Assume the same train to be equipped with the quick-action triple valves of patent 360,070, and state how much auxiliary reservoir air would be admitted to the brake-cylinder, through the port 31 controlled by the graduating valve, when the brakes were applied under the conditions stated in X Q. 607, that is to say, were to be applied quickly, with full pressure, for emergency purposes?

520 A. There would be practically no admission of auxiliary reservoir air into the brake-cylinder, under the conditions stated.

609 X Q. How would it be if the train were composed of forty or fifty cars, equipped in the same way and operated under the same conditions?

A. There would be substantially no difference in the operation between the long and the short trains

610 X Q. In the quick-action triple valve of patent 360,070, what is the use of graduating valve 29 and its port 31?

A. The use of graduating valve 29 is to aid the main valve 14 in performing the function of graduation. This result is accomplished by the moving of the triple-valve piston and the valve 29, without moving slide-valve 14, when the port 31 registers with the port 22.

With the construction as shown, as explained in a previous answer, a limited amount of pressure can be charged from the auxiliary reservoir to the brake-cylinder, by the movement of the triple-valve piston and slide-valve 29, without the necessity of moving the valve 14, and this mode of operation enables a smaller amount of

pressure to be charged into the brake-cylinder than would be the case if the valve 29 were removed, and graduation accomplished entirely by means of the movement of the slide-valve 14. Generally speaking, valve 29 aids the triple valve in performing the function of graduation more perfectly than the same work could be done without it, but its presence is in no way essential to the performance of the functions of the device shown in patent 360,070.

611 X Q. In the triple valve of patent 360,070, what would be the result if the port 35 were plugged?

A. In making an emergency application of the brakes, no appreciable auxiliary reservoir pressure would enter the brake-cylinder, if no other change were made in the construction of the device in question.

612 X Q. In such case, how much air pressure would get into the brake-cylinder, in attempting to make a quick application of the brakes?

521 A. Assuming a travel of six and a half inches for the brake-cylinder piston, and assuming a pressure of seventy pounds in the train-pipe, forty-three pounds would be admitted to the brake-cylinder.

613 X Q. If you based your last answer on an experiment or test of the matter, please state under what conditions such experiment was made.

A. The test was made upon a test-rack, with fifty triple valves, made substantially in accordance with the appliance shown in patent 360,070, and the result given was obtained by stopping up the port 35 and then making an emergency application of the triple valves.

In the test referred to, I am not sure that the graduating port was also stopped, but in other tests of a similar kind, it was found that the stopping of the graduating port and the port 35, did not materially, if at all, affect the amount of brake-cylinder pressure in making an emergency application, as compared with similar tests in which the port 35 alone was stopped.

614 X Q. In the triple valve of patent 360,070, if the port 42 were plugged and the valve 41 removed, what would be the effect in the operation of the structure?

A. It would operate as a plain triple valve.

615 X Q. In such case, what would be the action of the triple valves in a train of cars, if the train should accidentally break in two, and thereby suddenly discharge the air from the train-pipe?

A. If the train were of considerable length, the triple valves nearest to the fracture in the train-pipe would be operated so as to admit auxiliary reservoir air through port 35, and those on the rear portion of the train would probably admit a considerable portion of the auxiliary reservoir air to the brake-cylinder through port 31. If the train were a short train, then it is probable that all of the triple valves would operate so as to cause auxiliary reservoir air to pass through port 35 to the brake-cylinder.

522 The structure referred to was not designed or intended to be operated in the manner described in this question.

616 X Q. Under the conditions stated in my last question, that is to say, with the ports 42 plugged and valves 41 removed, and in the act of making an automatic application of the brakes, consequent upon the breaking in two of the train-pipe, how would the operation of the structure compare with that of the triple valves of patent 220,556, when in the act of making a similar automatic application of the brakes.

A. The movement of the triple-valve pistons would be substantially the same in both cases, but, with the device shown in patent 220,556, the flow of pressure from the auxiliary reservoir to the brake-cylinder of those triple valves that immediately uncover the port C by the full piston traverse, would be considerably more rapid than would be the case with the triple valves of patent 360,070, having a similar piston travel, and regulating the flow of air from the auxiliary reservoir to the brake-cylinder by means of port 35, because the port C is much larger than the port 35.

If the train were of considerable length, the operation of the structures on the rear of the train would be substantially the same. That is to say, in the device of patent 360,070, practically full auxiliary reservoir pressure would be charged into the brake cylinder through the port 31, and in the structure of patent 220,556 through the port s^1.

617 X Q. In said train having the triple valves of patent 360,070, with the passage 42 plugged and valve 41 removed, said triple valves would perform the four following functions, would they not?

1st. To admit air from the main air pipe to the auxiliary reservoir;

2d. To admit air from the auxiliary reservoir to the brake-cylinder, through the port controlled by the graduating valve 29;

3d. To admit air from the auxiliary reservoir to the brake-cylinder through the port 35; and

523 4th. To exhaust air from the brake-cylinder to the atmosphere?

A. The operations of the valves as described, upon a train of considerable length, would be substantially as follows:

If a reduction of pressure were made in the train-pipe, for the purpose of applying the brakes to a limited amount of auxiliary reservoir pressure, the triple-valve pistons would probably move to a point where communication would be opened from the auxiliary reservoir to the brake-cylinder through port 31, and, when the desired pressure had been charged into the brake-cylinder, communication between the auxiliary reservoir and the brake-cylinder would be cut off by the return traverse of the triple-valve piston, and this would be the mode of operation of all of the triple valves, when performing graduating work.

If it were desired to make a full application of the brakes, a full or complete reduction of train-pipe pressure would be made, and this would cause the triple-valve pistons of the devices nearest the point of the train-pipe opening, to make their complete traverse, and admit auxiliary reservoir pressure to the brake-cylinder, through port 35.

The pistons of the triple valves more remote from the point of train-pipe opening, would move to a point where the port 31 would open communication between the auxiliary reservoir and the brake-cylinder, and a portion of the auxiliary reservoir pressure would be charged into the brake-cylinder, and then the piston would complete its travel, and open communication between the auxiliary reservoir and the brake-cylinder, through port 35.

The pistons of the triple valves, on the rear portion of the train, would move to a point where communication between the auxiliary reservoir and the brake-cylinder would be made through the port 31, and complete auxiliary reservoir pressure would be charged into the brake-cylinder, before the pistons completed their entire traverse.

524 The operations of charging train-pipe pressure into the auxiliary reservoir, and exhausting air from the brake-cylinder to the atmosphere, would be performed in the usual manner.

618 X Q. With the explanations given in your last answer, the answer to my interrogatory 617 is *yes*, is it not?

A. It does not seem to me that the admissions of auxiliary reservoir air through ports 35 and ports 31 to the brake-cylinder are separate functions, otherwise I should suppose that the general assumptions of X Q. 617 were correct.

619 X Q. The admission of auxiliary reservoir air to the brake-cylinder through port 31, and the admission of auxiliary reservoir air to the brake-cylinder through port 35, are performed by different ports, at different positions of the main valve 14, and under different conditions, are they not?

A. They are performed by different ports, and by different positions of the triple valve piston, but, as previously explained, under conditions of actual practice and under the same circumstances, some valves perform the admission through port 31, some through both ports 31 and 35, and some through port 35 alone.

620 X Q. Assume a train of five passenger cars, equipped with the triple valves of patent 360,070, having the passages 42 plugged and valves 41 removed, and state whether said triple valves would or would not perform, under all the conditions of actual use, the four functions specified in X Q. 617?

A. The operations of the triple valves in question, under the conditions named, would usually be, to admit auxiliary reservoir pressure to the brake-cylinder through the port 31, in making a graduated application of the brakes, and through port 35 in charging full auxiliary reservoir pressure into the brake-cylinder, although the operation of charging full auxiliary reservoir pressure would not be so quickly performed as if the traverse of the triple-valve
525 piston were limited to a point that would fully open port 31, as that port is considerably larger, in the structure of patent 360,070, than port 35, and such limitation of travel would obviously follow the stopping up of port 42 and the removal of valve 41.

It is also probable that, in making graduating applications of the brakes, auxiliary reservoir air would be admitted to the brake-

cylinder through the port 35, instead of port 31, upon the triple valves nearest the locomotive.

The functions of feeding train-pipe pressure into the auxiliary reservoir, and releasing train-pipe pressure to the atmosphere, would be performed in the usual manner.

621 X Q. With the explanations given in your last answer, the proper answer to X Q. 620 is "They would," is it not?

A. Referring to X Q. 620, it seems that this question refers to X Q. 617, and this question seems to assume that the admission of auxiliary air through the ports 31 and 35 are several functions, and as I do not regard the matter in this light, my answer would not be as stated.

622 X Q. If the admissions of auxiliary reservoir air through port 31, and through port 35, are properly to be regarded as separate functions, then the triple valves referred to in X Q. 620 would perform the four functions specified in X Q. 617, would they not?

A. If the admissions of auxiliary reservoir air to the brake-cylinder through ports 35 and 31, are two separate and independent functions, then the addition of the functions of admitting train-pipe air to the auxiliary reservoir, and releasing air from the brake-cylinder to the atmosphere, would, with the two assumed functions, make four in all.

623 X Q. And they would be the four functions specified in X Q. 617, would they not?

A. Yes.

624 X Q. You have heretofore testified that the triple valves of patent 360,070, with the passages 35 plugged, and with no
526 other change in the structures shown in said patent, would admit but forty-three pounds air pressure into the brake-cylinder; how much is that short of the full amount which would be admitted to the brake-cylinder by the same valves, under the same conditions of pressure in the auxiliary reservoir and train-pipe, when the ports 35 were not plugged?

A. About twenty pounds.

625 X Q. The function of admitting that twenty pounds to complete the pressure in the brake-cylinder, is a function performed by the port 35, and not by the port 31, am I not right?

A. You are correct as to the structure shown in patent 360,070, but it could be equally performed by port 31.

626 X Q. How can that be true, in view of the fact to which you have just testified, namely, that when port 35 was plugged, the said twenty pounds of air pressure were not admitted to the brake-cylinder, although the port 31 was not plugged?

A. I did not intend to convey the impression that it could be equally well done, in the structure as shown in patent 360,070, by the port 31, as by port 35, without a structural modification. What I had in mind was, that the making of a cavity in the face of the slide-valve, as shown in the drawing "Exhibit Westinghouse Modification," would permit the feeding of the additional auxiliary reservoir pressure into the brake-cylinder through port 31.

627 X Q. The cavity marked *x* in Complainants' Exhibit West-

inghouse Modification, and described in your answer to Q. 450, is merely the mechanical equivalent of the port 35, is it not?

A. It is not the exact mechanical equivalent of port 35.

628 X Q. Why not?

A. The construction shown in port 35 is such, that communication between the auxiliary reservoir and the brake-cylinder is cut off, during that portion of the traverse of valve 14 when the metal of the slide-valve between the ports 31 and 35, is passing over port 22, and in the modification referred to, the communication
527 between the auxiliary reservoir and the brake-cylinder is continuously open, from the time the port 31 registers with the port 22, until the triple-valve piston has completed its traverse.

629 X Q. Would this difference make any real, substantial, practical difference in the operation of the triple valve?

A. If properly made, it would have no substantial effect upon the practical operation of the device.

630 X Q. Assuming the triple valve of patent 360,070 to be used without any modification or change whatever, then the function of admitting the twenty pounds to complete the pressure in the brake-cylinder, as stated by you in answer to X Q. 624, and as referred to by me in X Q. 625, is a function performed by the port 35, and not by the port 31, is it not?

A. Under the conditions stated, the function is performed by the port 35.

631 X Q. Is it your understanding that the defendants' quick-action triple valves have the same general mode of operation as the quick-action triple valves of patent 360,070?

A. It is.

632 X Q. In the complainants' quick-action triple valve of patent 360,070, does not the port 35 admit auxiliary reservoir air to the brake-cylinder, at exactly the same point in the movement of the triple-valve piston, that said valve would admit auxiliary reservoir pressure to brake-cylinder, provided the port 42 were plugged, and the valve 41 removed.

A. It is not the only place in which auxiliary reservoir pressure would be admitted to the brake-cylinder, in the structure shown in patent 360,070, and it is not the place at all by which auxiliary reservoir pressure would be admitted to the brake-cylinder in actual practice, if the other obvious changes were made in the general structure, at the time the port 42 was plugged and the valve 41 removed.

As previously stated, under some conditions, the port 35 does admit auxiliary reservoir pressure to the brake-cylinder, and
528 the conditions and circumstances under which it so acts have been described in detail.

633 X Q. Having again answered a question that I did *not* ask you, will you now please answer the question that I *did* ask you, bearing in mind that said question contemplates no changes in the structure except such as are specified in the question itself?

A. I do not know of any other way to truthfully and *and* intel-

ligently answer the question than that contained in my previous answer.

The question X Q. 632, assumes that port 35 always admits air from the auxiliary reservoir to the brake-cylinder, when the triple-valve piston has made its complete traverse, and, as previously and frequently explained, under conditions of actual practice, it will often occur that there will be no flow of auxiliary reservoir pressure through the port 35 to the brake-cylinder, when the port is opened, for the reason that full auxiliary reservoir pressure has already passed into the brake-cylinder through port 31.

When the structure of patent 360,070 is made and operated in accordance with the illustration, auxiliary reservoir pressure will always flow through port 35, when the triple-valve piston is in a position to open communication from the auxiliary reservoir to the brake-cylinder, through that port.

634 X Q. The question assumed nothing of the kind. It simply assumed that with the triple valve of patent 360,070, auxiliary reservoir air would, under certain conditions, pass through port 35 to the brake-cylinder, because you have so testified. It assumed also that the same valves, with the port 42 plugged and the valve 41 removed, would, under certain conditions, permit air to flow from the auxiliary reservoir to the brake-cylinder, through the port 35, because you have so testified. And it simply asked you whether, with the triple valve of patent 360,070, the port 35 does not admit auxiliary reservoir air into the brake-cylinder, at exactly the same point in the movement of the triple-valve piston, that it would admit such auxiliary reservoir air to pass from the auxiliary
529 reservoir to the brake-cylinder, through the port 35, if port 42 were plugged, and valve 41 removed.

As you evidently misunderstood the meaning of X Q. 632, I now ask you again to answer it in view of the explanation of its meaning which I have just given.

A. As I now understand the question, you desire to know if, *under certain conditions*, auxiliary reservoir pressure will be charged into the brake-cylinder through port 35, when the structure of patent 360,070 has port 42 plugged, and valve 41 removed, with the triple-valve piston in the same position that it is in, in the structure of patent 360,070 without modifications, when the port 35 always admits auxiliary reservoir pressure to the brake-cylinder.

If I understand you correctly, my answer is, yes.

635 X Q. That does not quite express the meaning of my question, but I will try to make it clear by another.

Assume *any* condition of the triple valve of patent 360,070, under which port 35 admits auxiliary reservoir air to the brake-cylinder, and assume *any* condition under which the same triple valves, with port 42 plugged and valve 41 removed, the port 35 will admit auxiliary reservoir air to pass to the brake-cylinder, and state whether the position of the triple-valve piston will not be precisely the same in each instance, namely, will it not be at the extreme end of its full stroke in the direction towards the train-pipe.

A. In the construction shown in patent 360,070, and in the modi-

fication described, it is essential that the triple-valve piston should be in the same position, in each case, before there can be any flow of pressure from the auxiliary reservoir to the brake-cylinder through port 35. The question as to whether or not there *will* be a flow of pressure through port 35 when it is opened, depends upon whether or not the pressure in the auxiliary reservoir is greater than that in the brake-cylinder.

Adjourned to Wednesday, December 20, 1893, at 10 a. m.

530 NEW YORK, *December* 20, 1893—10 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of H. H. WESTINGHOUSE resumed:

636 X Q. In the defendants' quick-action triple valves, if the port *i* (40) be plugged, will the device still be capable of quick action?

A. It will be capable.

637 X Q. Assume said port *i* (40) to be plugged, and assume the normal pressure of seventy pounds to be present in the auxiliary reservoir and train-pipe, and that a quick action be made under those conditions, and state how much air pressure will enter into the brake-cylinder in such case.

A. About sixty pounds.

638 X Q. With such port *i* (40) plugged, would the defendants' apparatus be capable of performing the graduating function?

A. No.

639 X Q. With such port *i* (40) plugged, how many valves would take part in the performance of the quick-action function by defendants' triple-valve apparatus—I mean how many valves would take part in the admission of air pressure into the brake-cylinder, exclusive of the valve which closes the exhaust from the brake-cylinder to the atmosphere?

A. Two, the valve 22 (15) and check-valve 26 (9).

640 X Q. Assume the quick-action triple valve of patent 360,070 to have the passage 31 plugged, and that, with a normal pressure of seventy pounds in auxiliary reservoir and brake-cylinder, a quick action were made, how many valves in said apparatus would take part in the admission of air pressure into the brake-cylinder, exclusive of the valve which closes the exhaust from the brake-cylinder to the atmosphere?

531 A. Three; the main valve 14, emergency valve 41 and check-valve 49.

641 X Q. In the defendants' quick-action triple valves, the only difference that the plugging of the port *i* (40) would make in the operation of the apparatus, would be that it would eliminate or prevent the performance of the graduating function; am I not correct?

A. That is the effect it would produce.

642 X Q. And that is the only effect that it would produce, is it not?

A. I believe that is the only effect that will be produced.

643 X Q. In the suit of George Westinghouse, Jr., and The Westinghouse Air Brake Company, complainants, *vs.* The New York Air Brake Company, Isaac B. Newcombe, Royal C. Vilas, Charles A. Starbuck and John C. Thompson, directors, No. 4977, in the United States circuit court for the southern district of New York, the same being an infringement suit charging said defendants with infringing letters patent No. 376,837, No. 168,359, and No. 172,064, you testified as a witness for the complainants and gave the deposition contained in pages 160 to 177 of the printed record in that suit, did you not?

Objected to as not proper cross-examination.

A. I did.

644 X Q. In that deposition, X Q. 147 and your answer thereto were as follows, were they not?

"147 X Q. Do you agree with me that the invention described in patent 360,070 is not the combination of the train-pipe and the brake-cylinder by means of two passages, one controlled by a triple valve and the other controlled by an emergency valve?

"A. I think the construction shown in patent 360,070 con-
532 tains two passages from the train-pipe to the brake-cylinder—one controlled by the triple valve and the other by an emergency valve; but I am unable to state the nature of the invention that this patent relates to."

Same objection.

A. They were.

645 X Q. The emergency valve there mentioned by you was the valve 41, was it not?

Same objection.

A. It was.

646 X Q. In the operation of the quick-action triple valve of patent 360,070, for quick-action purposes, in the normal action of the valve 41, when said valve unseats to admit train-pipe air directly to the brake-cylinder, does it open its port 42 wide open, or is it intended to be able to adjust or graduate the opening of said port in a quick action, so as to admit more or less air to pass through port 42?

A. The intended operation of the device is to open the port 42 to its fullest extent, and there is no graduation of train-pipe pressure admitted through this port.

647 X Q. In X Qs. 598 to 601 inclusive, and your answers thereto, and in X Q. 605 and your answer thereto, you testified, in substance, that the defendants' apparatus, with the bushing 9 removed, would operate substantially like the triple-valve apparatus of patent 220,556; that being the case, it would not be capable of performing quick-action functions, would it?

A. It would not.

648 X Q. The restoration of the bushing 9, which was assumed to have been removed, would render the defendants' device a quick-

action triple valve, fully capable of performing the quick-action functions, would it not?

A. It would.

533 649 X Q. In your answer to Q. 449, you testified that the defendants' structures do not possess the capacity of producing the same effect, in a service application of the brakes, as is produced if the piston and valve H of patent 220,556 are allowed to make the extreme traverse which the patent shows they are capable of *of* making; what did you mean by that answer?

A. The idea intended to be conveyed was as follows: In the device of patent 220,556, limited amounts of auxiliary reservoir pressure, or the maximum amount, can be admitted, through either the small port s^1 or the larger port C, while, in the defendants' structure, the only admission of auxiliary reservoir pressure in process of operation is through the small valve port *i*.

The structure of patent 220,556, by means of this difference, has the capacity of two rates of application of the brakes by auxiliary reservoir pressure, under some circumstances, while the defendants' structure has only one rate for the purpose of application of brakes by auxiliary reservoir pressure.

650 X Q. In the defendants' structures, if the bushing 9 were removed, the structures would have the capacity of producing the two rates of applications to which you refer, would they not?

A. They would.

651 X Q. In the New York suit above referred to, No. 4977, one David Leonard Barnes was produced and examined as a witness for complainants, and gave a deposition printed on pages 177 to 189 of the complainants' printed record in that case. In his said deposition, on page 181, when speaking of the accidental breaking in two of trains, he testified as follows;

"Probably there are nine cases of breaking in two, under the conditions of present railroad service, in which the emergency feature is called into service and prevents wrecks, to every one case where the emergency feature is operative by the hand of the engineer in the cab, to prevent collision This shows the necessity of
534 having not only the quick-action feature, but also that what is more essential is, that that feature should be automatic."

Do you agree with Mr. Barnes in his said testimony above quoted?

A. Yes.

652 X Q. Said record in the New York case shows that your testimony quoted in X Q. 644 was given on the 14th day of January, 1892, and Mr. Barnes' testimony above quoted, was given on the 18th day of January, 1892, does it not?

Objected to as not proper cross-examination, irrelevant and immaterial.

A. Yes.

Redirect examination:

653 Re-D. Q. I understand from your answers 440 and 441 in chief,

that triple valves, such as were known in the art prior to 1887, possessed three functions, to wit:

First. The admission of air from the train-pipe to the auxiliary reservoir; *second*, the admission of air from the auxiliary reservoir to the brake-cylinder; *third*, the release of air pressure from the brake-cylinder to the atmosphere.

You have also stated in substance, in answer to X Q. 519, and other answers in your cross-examination, that the triple valve of patent 141,685, and others of earlier date than 1887, possessed the capacity or capability of providing for the admission of air from the auxiliary reservoir to the brake-cylinder, either of maximum pressure, or in various degrees less than the maximum pressure.

As a mechanical engineer, familiar with air-brake practice, please state what, if any, difference of function, principle, or mode
535 of operation existed, in any of the triple valves prior to 1887, to which you have referred, in effecting the admission of reservoir air to the brake-cylinder, either at maximum pressure or at a lesser degree of pressure, and, if such admission function is to be divided, into how many different degrees less than the maximum would it be possible to divide it?

Objected to as vague and immaterial.

A. All of the valve structures in question perform the function of admitting auxiliary reservoir pressure to the brake-cylinder in the same general manner, and, while some of the later constructions facilitated the charging of small amounts of pressure into the brake-cylinder, yet the mode of operation in every case was practically the same.

I do not see that the functions can be divided into degrees. The function was the same, and performed practically in the same manner, whether it was exercised to the extent of admitting all of the pressure into the brake-cylinder, or only some portion of it.

654 Re-D. Q. You have been cross-examined at some length as to whether or not the admission of auxiliary reservoir air to the brake-cylinder is *controlled* by the valve 22 (15) in defendants' structures, and in answer to X Q. 594 have admitted that defendants' valve 22 (15) has the capability of opening its port, under certain conditions of use, and thereby admitting air to flow from the auxiliary reservoir to the brake-cylinder through the port which it opens.

So far as useful results in practical railroad service are concerned, to what extent, if at all, is the capability of valve 22 (15), above referred to, a necessary or a useful feature of defendants' structures?

A. It is not a needed or useful device, in practical operation, for the admission or control of auxiliary reservoir pressure.

655 Re-D. Q. Referring you to drawing "Exhibit Westinghouse Modification," please state of what valve port, and of
536 what valve port only, the valve recess, or port opening x, is a portion or extension, and with what valve port only it is in any manner operated?

A. Valve port 31.

656 Re-D. Q. In the construction illustrated in the drawing, Exhibit Westinghouse Modification, what, if any, *additional* valve port has been substituted for the eliminated valve port 35?

A. None.

H. H. WESTINGHOUSE.

Defendants' counsel states that complainants' counsel now informs him that he proposes to take the testimony of three witnesses, namely, Mr. David Leonard Barnes, as an expert, and Mr. Levi Close and F. Nellis, railroad locomotive engineers, as to certain questions of fact.

Defendants' counsel therefore makes the following statement:

Early in November, 1893, complainants' counsel notified defendants' counsel that he would proceed with complainants' testimony at New York city on November 10th. Defendants' counsel, being unable to attend upon the same before November 24th, informed complainants' counsel to that effect, and suggested that complainants' counsel commence on November 24th, 1893, instead of November 10th, 1893, and that, in such case, defendants' counsel would be willing to extend complainants' time for taking testimony, so as to make up for the time lost between November 10th and November 24th. Complainants' counsel thereupon courteously assented, on condition that complainants' time should be extended as above stated. Defendants' counsel thereupon, in writing, agreed to extend complainants' time for taking testimony to and including December 15th, 1893.

537 The taking of complainants' testimony, accordingly commenced at New York city on the 24th day of November, 1893, with the testimony of Mr. Henry F. Newbury, their expert, and continued, from day to day, until Mr. Newbury's testimony was concluded, at noon of Thursday, December 7th, 1893. On Wednesday afternoon, December 6th, complainants' counsel informed defendants' counsel that after Mr. Newbury's cross-examination was completed he should take the balance of his testimony at Pittsburgh, Pa., commencing Monday morning, December 11th. Defendants' counsel protested against the change from New York to Pittsburgh, and requested complainants' counsel to produce his witnesses at New York and proceed with his testimony there.

On Thursday morning, December 7th, complainants' counsel informed defendants' counsel that, in view of all the circumstances, he would proceed at New York instead of Pittsburgh, but that he should not be able to produce his further witnesses at New York until Monday morning, December 11th, and, as defendants' counsel understood him, that he might want a day or two after December 15th in which to complete his testimony. This conversation took place on the train coming down from the hotel to the place of taking testimony.

Mr. Newbury's testimony was closed at noon that day. During the day, while present in the room where the testimony was taken, the subject of further proceeding was brought up and discussed between complainants' and defendants' counsel, Mr. Charles B. Mann,

and Mr. George A. Boyden, and, as defendants' counsel remembers the facts, there was an agreement made orally between the parties present that, in view of the fact that complainants' counsel would lose Thursday afternoon, Friday and Saturday, complainants should have an extension of time to make up for such loss,
538 and that if complainants' testimony should run a day or two longer than even that, then defendants and their counsel would not object. Complainants' counsel stated, during both of those conversations, namely, in the morning coming down, and during the day in the presence of Mann and Boyden, that he proposed to examine only two witnesses, to wit, viz. H. H. Westinghouse and David Leonard Barnes.

The above states the understanding between counsel and parties, substantially as it is remembered by defendants' counsel, and as it was understood by him at the time; and with that agreement, an adjournment was taken to Monday morning, December 11th.

On Monday morning, December 11th, complainants' counsel commenced the examination of Mr. H. H. Westinghouse at New York city and continued it until the close of the day's session on Thursday, December 14th. The cross-examination then commenced and continued until Wednesday noon, December 20th.

At the close of Mr. Westinghouse's testimony, complainants' counsel notified defendants' counsel that he desired to adjourn to Thursday morning, December 21st, when he would proceed with the testimony of Mr. Barnes, and that he also proposed to take the testimony of Mr. Close and Mr. Nellis. Defendants' counsel stated that, according to his understanding of the arrangements made between counsel and parties, complainants' time for taking testimony, even under the extension granted, had already expired, and that he objected to the testimony being prolonged indefinitely. Complainants' counsel stated, in reply, that, according to his understanding of the arrangement, he was to have all the further time that he needed to complete his testimony, provided that he went right along with it, without any delay, until it
539 should be completed, and that to prevent him from taking the testimony of Mr. Barnes, Mr. Close, and Mr. Nellis, would be to deprive him and his client of a portion of the evidence which they desired to take in their behalf. To this, defendants' counsel replied, inquiring what the testimony of Mr. Close, Mr. Nellis, and Mr. Barnes would be, and was informed that the testimony of Mr. Close and Mr. Nellis would relate to certain facts in their experience with defendants' quick-action brakes, and that the testimony of Mr. Barnes would be in the nature of expert testimony. Defendants' counsel, thereupon, stated that he did not wish to deprive complainants of any of their evidence even though, according to his understanding, complainants' time had expired, and that, therefore, he would be willing to stipulate, and would stipulate on the record, that Mr. Close and Mr. Nellis would testify to the facts which complainants' counsel had stated they would swear to, and also to stipulate on the record that Mr. Barnes would testify in corroboration of Mr. H. H. Westinghouse, and in opposition to the testimony of

Messrs. Boyden and Church, wherever it might conflict with the testimony of Mr. Westinghouse. These stipulations would give the complainants the benefit of the evidence of all three of the witnesses whom they wished to examine, and would save the spending of any further time in completing the complainants' case.

Complainants' counsel expressed himself as willing to accept the stipulation as to the testimony which would be given by Mr. Close and Mr. Nellis, but unwilling to accept it in lieu of the testimony of Mr. Barnes, and stated that he wished to proceed with the testimony of Mr. Barnes on Thursday morning, December 21st.

Defendants' counsel now states that, with his understand-
540 ing of the arrangement, he is unwilling to consent to the
spending of any more time in the examination of complainants' witnesses, and that, if complainants desire to take such testimony, he shall object to it as taken out of time, unless the complainants shall first procure an order of court for such further extension, upon showing good cause therefor.

Inasmuch as complainants' counsel now proposes to adjourn until tomorrow morning, December 21st, 1893, and then to proceed with the testimony of Mr. Barnes, without obtaining an order of court further extending complainants' time, defendants' counsel states that, in view of prior imperative engagements, made upon the understanding that complainants' time for taking testimony would not run more than two or three days beyond December 15, he will be unable to be present during such taking of Mr. Barnes' testimony, and that, if such testimony be taken, he shall, at the hearing of the cause, object to it as taken out of time and without authority of law. He further gives notice to complainants' counsel that if the latter shall apply to the court for an extension of time for taking testimony, the defendants will, at the same time and place, apply to the court for an order fixing the day of hearing at some definite future time which will enable the counsel on both sides to prepare and print their briefs and get ready for the argument.

Mr. J. Snowden Bell, of counsel for complainants, desiring, at the outset, to be understood that he does not make, even by implication, any reflection whatever upon counsel for defendants, as to his misunderstanding of the clear and specific agreement entered into between counsel, states as follows:

In the first place counsel for defendants has omitted to state that
which is the fact, to wit, that counsel for complainants, some
541 time in the latter part of October, 1893, wrote counsel for de-
fendants, proposing to commence the taking of complainants' testimony in reply, at a much earlier date than November 10th, being as counsel for complainants now remembers, on or about November 1st, 1893, and possibly earlier, but not being able to refer to copies of his correspondence, which are in his Pittsburgh office, he cannot, with absolute accuracy, state the date at which he then proposed to commence.

Counsel for defendants replied, in substance, that he would be engaged in other cases, at and about the time suggested, and up to November 8th, on which date he stated that he had an engagement

before the United States circuit court, or circuit court of appeals, in some western circuit. Counsel for complainants remembers it as being in Iowa, but counsel for defendants states that it was an engagement in Milwaukee, which is doubtless correct. Counsel for complainants thereupon, and by reason of the engagements of defendants' counsel, and for no other reason, delayed the commencement of his testimony until November 10th, being, as he supposed, the earliest day that defendants' counsel could attend, and thereby losing about ten days or more of the time allotted him.

Upon writing defendants' counsel and suggesting November 10th as the day of commencement, defendants' counsel replied in substance, that in view of his engagements, it would be a personal favor or accommodation to defendants' counsel to postpone the taking of complainants' testimony in reply until November 24th, and that, in such case, defendants' counsel would correspondingly extend complainants' time, which he accordingly did in writing, but no allowance whatever was made for the time which had theretofore been lost by reason of defendants' counsel's western engagement up to November 8th.

542 As stated by counsel for defendants, the question as to continuing testimony, after Mr. Newbury's cross-examination should be completed, was discussed between counsel on Wednesday afternoon, December 6th, and, in view of the unwillingness expressed by defendants' counsel to have the further examination of the witnesses proceed in Pittsburgh, counsel for complainants sought to make some agreement with defendants' counsel which should cover this point, as well as cover such further extension of time as might be necessary to complete complainants' evidence, and which further extension complainants' counsel did not for a moment suppose defendants' counsel would refuse, in view of the delay occasioned in beginning the testimony in reply, due altogether, as before stated, to the engagements of defendants' counsel.

On Thursday morning, December 7th, complainants' counsel met defendants' counsel at the Forty-second Street station of the Sixth Avenue railroad, and then and in the train coming down, made an agreement for an extension of time with defendants' counsel, which complainants' counsel perfectly and clearly remembers, it being a matter which he was then very desirous to satisfactorily arrange, and one which was very clearly impressed on his memory. That agreement was as follows:

Complainants' counsel stated to defendants' counsel that he would endeavor to arrange to bring his witnesses to New York and to take their testimony there, and take it continuously until completed, stating that he desired to take the testimony of Mr. H. H. Westinghouse and Mr. D. L. Barnes, and asked defendants' counsel whether, if he made such arrangement, defendants' counsel would allow him *whatever time might be necessary* to complete com-
543 plainants' evidence. Complainants' counsel remembers perfectly well, that there was not a word said, and not the slightest intimation given, that only a day or so, or any such comparatively short time, would be required, and the request for exten-

sion was made without any limitation whatever, either direct or such as could be implied in the terms of complainants' counsel's language. Defendants' counsel very readily and cheerfully, as it seemed to complainants' counsel, agreed to this proposition, without any discussion or objection, and appeared to be entirely satisfied with it.

Some time during the morning, while the depositions were being taken, there was some conversation with reference to an extension of time with Mr. Charles B. Mann, of counsel for defendants, Mr. Mann asking something as to the conclusion of the testimony, or about going to Pittsburgh, and complainants' counsel replying that he had made an agreement for an extension of time with Mr. Hill, of defendants' counsel, under which the testimony would be taken here in New York. Mr. Mann appeared to be entirely satisfied with this statement, and whether he was or not, no discussion whatever was held with him, or with any one else, by complainants' counsel, as the latter considered his agreement with Mr. Hill, as above stated, to be conclusive, and did not see the necessity of discussing it with anybody else. After the conclusion of the testimony on that day, Mr. Bell saw Mr. George H. Christy, managing counsel for complainants, and reported to him the agreement that he had made with Mr. Hill, in terms substantially as above stated. He went to Pittsburgh that same night, made the necessary arrangements with his witnesses, and commenced and continued the
544 further taking of testimony on December 11th, as stated by defendants' counsel, closing the redirect examination of Mr. Westinghouse this afternoon, when, to his extreme surprise, he discovered that defendants' counsel had wholly misunderstood the terms of the extension made by him, and now was desirous of cutting short the further taking of testimony.

In view of the position taken by defendants' counsel, as indicated in his preceding statement, complainants' counsel thinks it may be the proper course to submit this question to the court, although as he understands the practice in this circuit, the taking of testimony which has been continued after the expiration of a limit fixed by the court, or of a stipulation of the parties, cannot be summarily abridged by either party, and cannot be terminated except by an order of the court, or the consent of the parties.

Whether or not the same practice prevails in the Maryland district, complainants' counsel does not know, and he therefore gives notice on the record that on tomorrow, Thursday, December 21st, 1893, at 10 o'clock a. m., or as soon thereafter as counsel can be heard, he will move such judge as may then be sitting in the United States circuit court for the district of Maryland, for an order extending the time for the taking of complainants' proofs in reply, for the period of ten days from date.

Defendants' counsel accepts service of the notice given by Mr. Bell of his proposed application to the court at Baltimore tomorrow and notifies complainants' counsel that, at the same time and place, application will be made on behalf of the defendants, for an order fixing the time of trial at some reasonable date in the future.

Defendants' counsel further states that his memory is very
545 strongly impressed with the fact that during the conversation with complainants' counsel on the elevated railroad train on the morning of December 7th, or during the conversation between Mr. Bell, Mr. Mann, Mr. Boyden and Mr. Hill on the same day, reference was, in terms, made to the extension for two or three days immediately after the 15th of December. At all events, inasmuch as complainants' counsel then proposed to take only the testimony of Mr. H. H. Westinghouse and Mr. Barnes, and there was nearly a week remaining for that purpose, defendants' counsel throughout the entire matter, had in mind only a short extension of two or three days after December 15th, so as to practically make up for the time lost between December 7th and December 11th by the adjournment that then occurred, and never dreamed of an indefinite extension of time being meant or understood by either counsel, nor that any other witness was to be examined except Mr. Westinghouse and Mr. Barnes. The fact that it was also proposed to examine Mr. Close and Mr. Nellis was first made known to defendants' counsel after the close of the redirect examination of Mr. H. H. Westinghouse today.

In view of the evident misunderstanding between counsel, defendants' counsel concurs with complainants' counsel in thinking that the matter had better be settled by the court.

Adjourned to Friday, December 22d, 1893, at 10 a. m.

546 NEW YORK, *December* 22, 1893.

Met pursuant to adjournment.

Present: *J. Snowden Bell, Esq.*, of counsel for complainants, and no appearance on behalf of defendants.

In accordance with a stipulation extending complainants' time for taking proofs in reply, made and filed in the clerk's office of the United States circuit court for the district of Maryland, the further taking of testimony is adjourned to Tuesday, January 2, 1894, at 11.30 a. m.

NEW YORK, *January* 2, 1894—11.30 a. m.

Met pursuant to adjournment.

Present: *J. Snowden Bell, Esq.*, of counsel for complainants; *Charles B. Mann, Esq.*, of counsel for defendants.

DAVID LEONARD BARNES, a witness produced on behalf of the complainants, having been duly sworn, deposes and says in answer to interrogatories propounded to him by J. Snowden Bell, Esq., of counsel for complainants, as follows, to wit:

657 Q. What is your name, age, residence and occupation?

A. David Leonard Barnes, age 35, Chicago, Ill., consulting engineer in railway and mechanical construction.

658 Q. To what extent are you practically familiar with the construction and operation of railroad machinery, more particularly with fluid-pressure brake apparatus?

A. I have been intimately connected with railroad work since 1878, and previous to that time I made a study of mechanical
547 and railroad engineering at Brown University, Providence, and Massachusetts Institute of Technology, at Boston. Prior to entering those colleges, and during the vacation, I spent, in all, about three years at civil engineering.

After leaving the college, I worked in the machine shop, and other departments of the Rhode Island locomotive works, in Providence, R. I., and the Hinckley locomotive works in Boston, Mass. In 1880, I entered the drawing-room department of the Rhode Island locomotive works and shortly thereafter was in charge of the drawing-room and the mechanical engineering work of the company, with the exception of one year, during which I was mechanical engineer for the Rome locomotive works at Rome, N. Y. During the succeeding period, up to the fall of 1887, it was my duty to design and test railroad apparatus, more particularly with reference to rolling stock, and it was necessary for me to know, and be familiar with, the details of construction and operation of air brakes as used in practical railroad service, and in 1887 I left the Rhode Island locomotive works, to go round the country with the Westinghouse experimental fifty-car air-brake train, for the purpose of familiarizing myself with the details of practical operation of the Westinghouse quick-action brake, which was then being brought into practical service. This I did preparatory to taking up a business of my own, as consulting engineer, in the city of Chicago. I commenced that business in November, 1887. Since that time I have acted as consulting engineer on special work for several railroads, among them the following: Chicago, Burlington and Quincy, the Mexican Central, the Baltimore and Ohio, the Illinois Central, the Chicago and South Side Rapid Transit Company, who built and operate the Alley Elevated in Chicago, and the Metropolitan Elevated in Chicago. I designed the compound locomotives, and arranged the braking systems, and adapted the quick-action brakes for use on the Alley elevated road just mentioned, and did all the
548 principal mechanical engineering of that road during its construction and up to this time.

I made a study of air brakes, both vacuum and compressed air, as used here and in foreign countries, and made a special study of the quick-action brakes, as brought out and developed in the Masters Car Builders' Association air-brake tests, at Burlington, Iowa, in 1886–1887. I have designed several quick-action air-brake triple valves, and have acted as consulting engineer for two manufacturers of air brakes of the quick-action type, and have made expert reports on five different air-brake systems. My work has been such as to bring me into intimate relation with the practical operation of air brakes, and I have conducted special tests of fifty-car air-brake trains in actual operation on railroads. This is the experience that I have had which relates more particularly to the use of automatic and quick-action brake systems.

659 Q. Have you read the depositions of defendants' witnesses, George A. Boyden and Joseph B. Church, in this cause?

A. Yes.

660 Q. As a practical expert in the art of automatic brakes for railroads, please state the several different functions, and the distinguishing and essential characteristics of a "triple valve," as such appliance was used in said art prior to 1887?

A. Prior to 1887, triple valves had three distinct functions, performed in a varying degree, and characterized as follows:

First function. When a locomotive is coupled onto a train equipped with triple valves such as were used in the art prior to 1887, air was admitted to the train-pipe from the main reservoir on the engine, and from the train-pipe was admitted to the auxiliary reservoir, by the triple valve.

Second function. After the train had started, and it was desired to stop, air was let out of the train-pipe in one of several ways, and air was admitted from the auxiliary reservoir to the brake-cylinder.

549 Third function. After the train had been stopped and it was desired to release the brakes, the pressure in the train-pipe was restored, by admitting air from the main reservoir on the engine, through the engineers' valve, to the train-pipe, and the triple valves operated to open a passage from the brake-cylinder to the atmosphere, and permit the pressure in the brake-cylinder to be released.

These are the three functions, and the only functions, which were performed by triple valves prior to 1887, and, as I have said before, these functions were performed in a varying degree as follows:

When the locomotive was coupled on to the train, and the air pressure admitted from the main reservoir on the engine, the triple valve operated to open a passage from the train-pipe to the auxiliary reservoir, quickly or slowly, fully or partially open, according to the size of the train-pipe, the pressure carried on the engine reservoir, and the position of the triple valve in the train. Generally, the valves on the front cars operated at once to open the full charging port, while those in the rear operated later, and the charging port was opened, fully or partially, according to the impulse given the piston or diaphragm of the valve by the incoming pressure, and according to the rapidity of increase of pressure in the train-pipe. If the pressure were increased very slowly, as is always the case in a long train at the rear, the charging port would be opened less rapidly, and sometimes, less fully, than when the pressure is increased more rapidly. It has been necessary, in the practical development of triple valves, to restrict the passage from the train-pipe to the auxiliary reservoir, in order to prevent the front brakes from being charged too quickly, and too long before the charging of the rear brakes. When this was not done, the front brakes became charged fully before the rear brakes were charged, and the reduction in the train pipe pressure, resulting from a subsequent charging of the rear brakes, caused the front brakes to apply, and this gave rise to practical difficulties. Necessarily,
550 any valve must open partially before it can open fully, and when the opening force is variable, the amount of valve opening may be, and will generally be, variable, also.

The second function of triple valves used prior to 1887 was performed in a variable way as follows:

In a short train, if the engineer operated the engineers' valve to let air out of the train-pipe in a rapid and energetic manner, the piston or diaphragm of the triple valve would move to its full stroke and open the application port or ports fully, and would then return quickly to the point where the application port was closed.

If the engineer operated the engineers' valve less energetically, the piston or diaphragm would move less forcibly and would open the application port to a less degree.

In a long train, the energetic movement of the engineers' valve would open the application port of the triples on the front cars at once and fully, while those on the rear cars would be operated less forcibly, and the port for application of the brakes would be opened in a less degree.

In the examples I have described, the function is, and the purpose is, to admit auxiliary reservoir pressure into the brake-cylinder to apply the brakes, and it is the same purpose, and the same function, whatever the amount of opening, or whatever be the force of the application of the brakes.

The variable performance of the third function is, as I have described in the case of the first and second functions, dependent upon the impulse which the valves receive from the variation in pressure in the train-pipe, and upon the rapidity of the increase or decrease of that pressure. The third function, which is that of release of the brakes, is generally performed quickly on the front of the train and more slowly at the rear. This is noticeable particularly in tests made of fifty brakes on a rack, where they can be observed
551 more carefully. If the piston or diaphragm of the triple valve is driven fully to the extreme of its stroke on the return, the release port is fully opened. As I have explained before, where there is a variable force operating a valve, the opening may be, and generally is, variable.

Having used the term function, I now wish to define the sense in which I have used it. The function of a valve or device is the purpose or office of the valve or device, and it has nothing whatever to do with its detail construction. It does not signify anything whatsoever in regard to location, dimensions, mass, or integrality.

In describing double, triple, quadruple, or any other compound valves, it is necessary to adhere closely to the functions of the valve, rather than the number of parts or details, for the reason that the number of functions is quite independent of the number of parts. For instance, in the arts there are quadruple and triple valves that have but two parts, and yet have quadruple and triple functions, as the case may be.

The concise reply to the question is, that triple valves, as used in the art of braking prior to 1887, have three distinct functions such as I have described, and these functions are all, and can all be, performed in a variable degree. The function is the same whether it is performed fully or partially.

661 Q. What, if any, distinguishing or essential characteristics

were possessed by triple valves, as known in the art prior to 1887, other or further than the structural capability of performing the three functions recited in the last preceding answer?

A. There were no other essential characteristics possessed by triple valves prior to 1887, or structural capabilities for the performance of any other than the three functions I have mentioned.

662 Q. The defendants' witnesses, Boyden and Church, have testified to the effect that triple valves proper, or triple valves such as were known in the art prior to 1887, had *four* separate functions (which they sometimes characterize as "valves" and sometimes as "valve functions") and also to the effect that the perform-
552 ance of the admission of auxiliary reservoir air to the brake-cylinder (characterized by you in answer 660 as the second function of a triple valve prior to 1887) is *one* function when effected to the full or maximum extent, and is *another* and a different function when effected in a lesser degree.

As a mechanical engineer familiar with air-brake practice, state what, if any, difference in function, or in the manner of the performance of function, existed or exists in plain triple valves as known prior to 1887, as between a full, and a partial or lesser, admission of auxiliary reservoir air to the brake-cylinder?

A. As I have said before, it is necessary, in describing compound valves, to adhere to the functions rather than the details, as the functions of a valve are no indication of the number of parts, therefore the use of the term "valves" in the testimony of the defendants' witnesses Boyden and Church, is indefinite, as there may be more or less "valves" without changing the number of functions.

The term "valve functions" I understand to mean the same as "functions," and to be in fact the functions of the valve.

The second function that I have described is the function referred to in the question I am now answering, and it is but one function, namely, the office of admitting air from the auxiliary reservoir to the brake-cylinder. To admit *a little* air is no different function than to admit *more* air. To apply the brakes *slightly* by the admission of auxiliary reservoir air to the brake-cylinder, is no different function from applying the brakes *harder* or *fully* by the admission of more air from the auxiliary reservoir to the brake-cylinder.

To further explain what I mean by this, I will recite similar examples:

The office, purpose, and function of a faucet used in plumbing, is to admit water from the water pipes to a basin or a receptacle. It is the same function that is performed when one pint of water is drawn through the faucet per minute, as when one gallon is
553 drawn per minute. No different function is performed when the faucet is partly opened than when it is full open. The single function or office is to permit water to be drawn from the water pipe in any quantity that may be desired.

In air compressors, there are arranged a number of inlet valves, all performing the same function of admitting air to the air-compressor cylinders, on the forward stroke, and closing to prevent the escape of air on the backward stroke. When the compressor is

running rapidly, all of these valves will lift considerably, and, when the compressor is running slowly, only a few of the valves will lift, and the lift will be less than before. The valves are many in number, for the purpose of getting a better practical operation. The function of each valve, or of all valves combined, whether lifting much or little, is the same and single function of admitting air to the compressor cylinder to any desired amount. It is no different function that is performed when all of the valves lift, than when one lifts, and it is no different function when the valves lift to the full extent of their stroke, from that performed when they lift but little.

For these reasons which I have explained, it is to me clear that the defendants' witnesses Boyden and Church are not justified in subdividing the single function of admitting air from the auxiliary reservoir to the brake-cylinder into two functions, which they have described individually as differing only in degree of performance of the same function. Functions of all valves, so far as I know, are performed in a varying degree, but this does not make a difference in function *per se*.

A more illustrative example of a variable degree of performance of a single function, is found in the well-known Corliss engine, where the steam valves have the single function of admitting steam from the boiler to the cylinder, and the amount of opening of the valves and the amount of steam admitted is varied to suit the
554 requirements of the work to be done. The same function is performed when steam is admitted for one-half of the stroke, as when admitted for the full stroke.

For the purpose of discussion or illustration, a function might be divided into degrees, but the difference in degrees would not make a difference in function; thus we have, in locomotive practice, the throttle valve partially open, half open, and full open, but the throttle valve performs the same function when open to either of these degrees.

663 Q. Are you familiar with the descriptive matter and representations of a quick-action triple valve contained in the specifications and drawings of the Westinghouse patent No. 360,070 in suit? In answering this, and any other questions which I may put to you regarding this or any other patent, you may understand that you are not interrogated as to the *claims*, and need not refer to them.

A. I am.

664 Q. In answer to question 6, in which he is asked to describe the construction and operation of the quick-action triple valve of the Westinghouse patent 360,070 in suit, defendants' witness, G. A. Boyden, makes the following statement, to wit:

"This is a valve mechanism used in automatic air brakes the functions of which are: 1st. To admit air from the main air pipe to the auxiliary reservoir, through the valve port or feeding-in groove 51, shown in Fig. 2 of complainants' patent No. 360,070. 2d. To admit air from the auxiliary reservoir to the brake-cylinder through the port controlled by the graduating valve 29, by the

preliminary movement of the piston 12. 3d. To admit auxiliary reservoir air to the brake-cylinder through the valve port 35 by the final movement of the piston. 4th. To exhaust air from the brake-cylinder to the atmosphere through the valve cavity 33. These four valves form what is commonly known as a 'triple valve' proper, as used in the art prior to 1887."

555 From your practical knowledge of the construction and operation of quick-action triple valves similar to that described and shown in patent 360,070, your knowledge of triple valves as known in the art prior to 1887, and your familiarity with the descriptive matter and drawings of patent 360,070, state whether or not the statement of Mr. Boyden above quoted is true and correct in fact.

A. The triple-valve functions Nos. 1, 2 and 3, that I have described as being all the functions performed by triple valves prior to 1887, are performed by the quick-action triple valve described and shown in patent No. 360,070, when operating as a plain triple valve, but are not performed as described by Mr. Boyden. I will quote from Mr. Boyden's reply:

"This is a valve mechanism used in automatic air brakes, the functions of which are:

"1st. To admit air from the main air pipe to the auxiliary reservoir, through the valve port or feeding-in groove 51, shown in Fig. 2 of complainants' patent No. 360,070" (D. R. p. 17).

This is correct.

"2nd. To admit air from the auxiliary reservoir to the brake-cylinder through the port controlled by the graduating valve 29, by the preliminary movement of the piston 12."

This is correct.

"3d. To admit auxiliary reservoir air to the brake-cylinder through the valve port 35 by the final movement of the piston."

This is incorrect, as it is impossible to open the port 35 when the quick-action triple valve of patent 360,070 is performing the functions of a triple valve known in the art prior to 1887. Port 35 cannot be opened without, at the same time, compelling the

556 quick-action triple valve of patent 360,070 to perform the fourth function, namely, quick action. This arises from the fact that port 35 cannot be opened without at the same time opening port 42.

"4th. To exhaust air from the brake-cylinder to the atmosphere through the valve cavity 33."

This is the third function of triple valves known in the art prior to 1887, and is correctly described by Mr. Boyden, with the single exception that Mr. Boyden has denominated it as the fourth function, which it cannot be; the triple valve known in the art prior to 1887 had but three functions.

"These four valves form what is commonly known as a 'triple valve' proper, as used in the art prior to 1887."

As I have said in a previous answer, it is indistinct and indefinite to describe the features of compound valves by the number of parts, for the reason that the number of parts is independent of the num-

ber of functions. Triple valves prior to 1887 had but three functions, although they may have had two, three, four, five or any number of valves or parts.

665 Q. If, instead of interpolating his alleged third function into a statement of the functions of the appliance of patent 360,070, when acting as a triple valve proper as used in the art prior to 1887, (which alleged function, I understand from your answer, cannot be performed except when the appliance is acting as a quick-action triple valve), Mr. Boyden had recited such alleged third function as a part of the operation of the appliance of patent 360,070 when it was *not* acting as a triple valve proper as used in the art prior to 1887, to what extent would you, in such case, have agreed with him?

A. I should have agreed with him exactly, with the exception of the following sentence:

557 "These four valves form what is commonly known as a 'triple valve' proper, as used in the art prior to 1887."

In this reply I refer only to that part of Mr. Boyden's reply to Q. 6 up to the point about line 70 ending "as used in the art prior to 1887."

666 Q. In his answer to Q. 6 Mr. Boyden states (pp. 18–19) that "To apply the brakes fully with the auxiliary reservoir pressure by the final movement of the piston 12, a sufficient amount of air is gradually exhausted from the main air pipe to move the piston its full stroke. This will bring the valve port 35 coincident with the passage 22, and thereby establish communication from the auxiliary reservoir to the brake-cylinder and fully apply the brakes with the reservoir pressure."

Is, or is not, this statement of Mr. Boyden's, true and correct in fact?

A. For the reason that port 35 cannot be opened without at the same time opening port 42 and causing the performance of the fourth function, namely, that of quick action, which is the admission of train-pipe pressure into the brake-cylinder to perform a quick and nearly instantaneous application of the brakes, it is clear that Mr. Boyden's statement is incorrect. Port 35 is useful for, and has no other purpose than is connected with, the performance of the fourth function. The application of the brakes "fully with the auxiliary reservoir pressure" can only be performed by the passage 31 controlled by valve 29, and this can only take place by and with the *preliminary* traverse of the piston 12.

667 Q. To what extent do you agree with Mr. Boyden's statement in folio 75, page 19, (D. R.) as to the "essential features" of the quick-action triple valve of patent 360,070?

558 A. Mr. Boyden's answer to Q. 6 in this regard is as follows, (D. R., p. 19.)

"The essential features of the device are: 1st, the *triple valve proper*, containing sufficient valves to make it perform the triple-valve functions, and 2nd, an '*additional or auxiliary* valve' to admit the main air-pipe pressure directly to the brake-cylinder."

I cannot find the term "additional" used in the specification and

description of patent 360,070. I quote from the specification of patent 360,070, page 4, line 20:

"Whereupon the piston 12 of the triple valve is forced to the extreme limit of its stroke in the direction of the drain-cup 19, carrying with it the stem 36 and auxiliary slide-valve 41, which instantly uncovers the port 42 and discharges air from the main air pipe through the opening of the check-valve 49 and the passages 46 and 48 to the brake-cylinder, and, each car being provided with one of these devices, it will be seen that they are successively moved with great rapidity."

The term "additional," as used by Mr. Boyden, carries with it a sense of separation, whereas the term "auxiliary" applies only to the function, and does not, in any way, imply what are the number of parts, or how located, and does not give any idea of integrality. I cannot find that the inventor, in the description and specification of the device of patent 360,070, conveyed, or intended to convey, the sense of integrality or non-integrality, when referring to, and describing, the auxiliary mechanism which performs the fourth function, namely, quick action.

Mr. Boyden is right in saying that one of the essential features of the device is that it shall contain "sufficient valves to make
559 it perform the triple-valve function," and these functions are the three that I have described in a previous answer.

The other essential features cannot be described as a single one, as stated by Mr. Boyden, to wit:

"An '*additional or auxiliary valve*,' to admit the main air-pipe pressure directly to the brake-cylinder,"

but should be described as follows:

First. The valve should contain sufficient parts, ports, valves and passages to enable it to perform the three triple-valve functions.

Second. The valve should contain sufficient parts, ports, valves and passages to enable the admission of train-pipe air directly to the brake-cylinder to be effected, upon the further and additional travel of the triple-valve piston, brought about by a greater reduction of the pressure in the train-pipe; the additional traverse of the piston and the reduction in the pressure in the train-pipe being greater than that used for the service application of the brakes. It matters not whether the parts, ports, valves or passages be combined in one piece, or be made up of a number of pieces, provided that the quick-action is performed in the manner I have described, namely, by the further traverse of the triple-valve piston over and above that used for service application.

Third. There should be a check-valve so located as to prevent the return of the air from the brake-cylinder to the train-pipe after the train-pipe air has entered the brake-cylinder.

These are the three essential features of the device described in patent 360,070, and, without either of these features, the quick-action triple valve would not be a practical quick-action triple valve for use in the art of braking at the present time.

In order that I may make myself clear in what I have said about quick action, I will now define what I mean by the term "quick action."

560 Quick action is the admission of air or train pipe pressure from the train-pipe to the brake-cylinder to perform two useful results, namely:

(*a*) The application of the brakes with greater force than can be obtained by applying them solely with full auxiliary reservoir pressure.

(*b*) To cause quick action to take place in the succeeding valves in a train, thus applying the succeeding brakes quickly and hastening the final application of all the brakes in the train.

In order that these useful and practical results may be obtained, it is necessary:

(*a*) That the air from the train-pipe to the brake-cylinder shall be admitted at once and in large quantity, so as to put a substantial amount of pressure in the brake-cylinder and produce a very substantial reduction of pressure in the train-pipe.

(*b*) That the passage from the auxiliary reservoir to the brake-cylinder shall be restricted, so as to prevent the early admission of a large volume of air from the auxiliary reservoir. Without this restriction, the brake-cylinder would be so completely filled with air pressure from the auxiliary reservoir, that a sufficient and substantial amount of air pressure from the train-pipe could not enter to perform the two results of quick action which I have named in this answer.

This restriction of the passage from the auxiliary reservoir to the brake-cylinder, renders it necessary that the passage from the train-pipe to the brake-cylinder shall be the larger of the two, and thus are formed differential passages, which are necessary to the practical operation of any quick-action triple valve. In the device shown in patent 360,070, the differential passages are port 42, the larger passage from the train-pipe, and port 35, the smaller passage from the auxiliary reservoir.

Fearing that I have not made the distinction between the terms "additional" and "auxiliary" sufficiently definite, I wish to add the following:

561 The term "auxiliary" does not imply location, dimension or integrality. It refers simply to the office, purpose, or function, and describes such office, purpose or function, as being one that assists or helps to perform. In this case the auxiliary action helps to apply the brakes with greater force when desired.

The terms commonly used in the description of mechanisms, to wit, "auxiliary," "supplemental," "separated," and "additional," are not synonyms. A supplemental or auxiliary device is one that assists in the performance of some function. It may, or may not, be separated, and it may, or may not, be integral.

A separated device is separate in structure, and is not integral.

The term "additional" is used both to describe integral parts having an additional function, and to describe non-integral parts which are additional, and yet have the same function, and in-

tegral parts which add to the integral structure and have the same function.

Practical examples of the application of these terms are as follows:

Adjourned to Wednesday, January 3, 1894, at 11 a. m.

NEW YORK, *January* 3, 1894—11 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of D. L. BARNES resumed:

A. to Q. 667 (continued). An example of "integral parts having an additional function" is found in the ordinary slide-valve of steam-engines. The part of the valve which controls the admission of steam from the steam chest to the cylinder, is integral with that part of the valve which controls the exhaust of the steam
562 from the cylinder to the atmosphere. The parts are integral, but the functions are different. The function of controlling the exhaust is additional to the function of admitting the steam.

An example of "non-integral parts which are additional and yet have the same function," is found in the inlet valve for air compressors, which I have referred to in a previous answer. The considerable number of inlet valves, in that construction, are non-integral with each other, and are additional, not in function but in parts; the function of all these valves for the inlet of air to the air compressor is the same.

An example of "integral parts which add to the integral structure and have the same function," is found in multiple ported and grated valves used in steam-engines. The multiple ports and edges of the valve are combined in the same integral structure, and they are additional to each other, and they have the same function, namely, the admission of steam to the steam cylinder.

The foregoing will perhaps illustrate the wide variation in meaning which the term "additional" has, and which makes it indefinite. A device may be additional as to function, as to integral structure, or as to the number of parts, and may, or may not, be auxiliary or supplemental.

Further examples of additional, supplemental, separate, and auxiliary devices, may be found in the art of braking, as follows:

In the device described and shown in patent 360,070, valve 41 has an auxiliary function to valve 29. It is supplemental, separated, and additional. It is additional as to the number of parts, and additional as to functions.

Defendants' quick-action triple valve, catalogue 1891, is a similar example. Valve 22 has an auxiliary function to valve *i*, *k*, *j*. It is supplemental, separated, and additional. It is additional as to the number of parts, and additional as to function.

Defendants' quick-action triple valve, catalogue 1889, differs
563 as follows: Valve 15, which corresponds in function to valve 22 of catalogue 1891, has an auxiliary function to valve

18, which corresponds in function to valve *i, j, k*, of catalogue 1891, but while it is supplemental and auxiliary, and additional in function, it is not separated and additional entirely as to the number of parts.

In conclusion then, as to the use of the term "additional" by Mr. Boyden, in the sense of being separated in structure, the term is indefinite, and I do not find it mentioned in the description of the device shown in patent 360,070, and it is not necessary, for the full performance of all the four functions of the quick-action triple valve shown in that patent, that there be any additional valve, in the sense of being separated as to structure. What is necessary is, that there shall be an auxiliary valve, (see page 4, lines 20–25, specification of patent 360,070), which shall have an auxiliary function, which shall be to perform quick action (defined as heretofore) upon the further traverse of the triple-valve piston.

It is true that in the drawing of patent 360,070, valve 41 is separated in structure, and therefore additional as to the number of parts, but this is immaterial, for the same essential characteristic feature and function of the device will be performed, in precisely the same way, if valve 41 was combined with, and was integral in structure with, slide-valve 14. The construction, as shown, is better, for some reasons, to use in practical braking, but an integral device, such as I have described, would do the work and perform the same useful result, namely, quick action, in the same way.

Again, for all the purposes of performing the fourth function of quick-action triple valves, valve 41 might be rigidly attached to stem 45, and these together rigidly attached to piston 12, and the device would then be an operative quick-action triple valve, which would perform the fourth and auxiliary function, in the same useful way as the device shown in patent 360,070.

564 Again, the device just described might be more integral by being attached to valve 14, and then, by the removal of valve 29, which would then become unnecessary, this more integral device would perform the fourth function of a quick-action triple valve, in the same way as before.

An actual example of a construction of this kind is found in defendants' quick-action triple valve, catalogue 1889. In that valve the auxiliary valve 15 is integral with the piston 12, and is not additional as to structure, and yet it performs the fourth function of quick-action triple valves, in the same useful way as the device shown in defendants' 1891 catalogue and in the drawings of patent 360,070, in both of which last mentioned, the part which performs the auxiliary or fourth function, namely, valves 22 and 41, are non-integral, and therefore additional as to the number of parts.

From the fact that the part which performs the fourth function of quick-action triple valves, in the three valves last mentioned, namely: the device shown in the drawing of patent 360,070, in defendants' 1891 catalogue, and in defendants' 1889 catalogue, is, in some cases, separated and non-integral, and in other cases is integral, it is clear that, because these devices all perform the auxiliary function, and are therefore auxiliary, the term "additional," in the

sense of being separated as to structure, should not be used for the description of the essential features and characteristics of the device shown and described in patent 360,070.

To sum up then as to the essential characteristics of the quick-action triple valve described in the specification of patent 360,070:

There must be sufficient parts, ports, valves and passages, integral or non-integral, to enable the performance of the three functions of plain triple valves.

There must be sufficient parts, ports, valve- and passages, integral or non-integral, to enable the performance of the auxiliary or fourth function, namely, quick action, of quick-action triple valves, upon the further traverse of the triple-valve piston over and above
565 that traverse which is used for the three functions of plain triple valves.

There must be a check-valve, so located, or a device of a similar nature, so arranged, that the air from the train-pipe, after having once entered the brake-cylinder will be retained there.

Counsel for defendants objects to all that part of the last answer in which the witness volunteered the statement and illustrations of his own peculiar views of the different meanings of certain words, as irrelevant and improper.

The said part referred to in the answer is further objectionable because it is not evidence, but is a mere argument volunteered by the witness.

Counsel further objects because some of the words, the meaning whereof he assumes to discuss, were not used by Mr. Boyden in the statement inquired about in the question, and that part of the answer therefore, is not proper in rebuttal.

Counsel further objects to testimony of this kind, because the witness is testifying relative to a patent which has definite limitations and restrictions in all the claims, as to which he is requested to pay no regard, and yet he seeks to expound the specification of that patent, and the structures therein described, in manifest and utter disregard of the said limitations and restrictions in the claims. This testimony therefore is improper.

Counsel for complainants is pleased to see that defendants' counsel correctly understands the purpose of the testimony of this witness, which is that of a mechanical engineer and not of a lawyer, but inasmuch as the claims of the patent in question, and the limitations, if any, which they contain, are matters of law, and not proper for discussion by this witness, counsel for complainants confesses
566 himself unable to see any impropriety in the witness having abstained from a discussion of them.

568 Q. To what extent do you agree with Mr. Boyden's statement in folio 82, page 21 (D. R.), as to the "essential features" of defendants' quick-action triple valve, plate XI 1891 catalogue?

A. Before making a concise reply to this question, I shall describe the valve, as to structure and operation, in order that my answer may be definite and clear.

In the defendants' quick-action triple valves, catalogues 1889 and

1891, there is a piston operated by variations in pressure in the train-pipe, the operating power being the momentary or continuous differential pressure on the opposite sides of the piston, just as is the case with all triple valves, quick action or plain, with which I am familiar.

This piston operates a valve which performs the three triple-valve functions used in the art prior to 1887.

A further traverse of the triple-valve piston, over and above that necessary to perform the three triple-valve functions just referred to, operates to perform the fourth function, namely, the quick action of the quick-action triple valves.

The defendants' quick-action triple valve is provided, like all other quick-action and plain triple valves, with the differential passages necessary to permit the momentary or continuous differential pressures, which are, and always have been, necessary to the operation of plain or quick-action triple valves so far as I know.

Defendants' quick-action triple valve is provided with a check-valve, which prevents the return of air pressure to the train-pipe from the brake-cylinder after it has once entered that cylinder from the train-pipe.

Mr. Boyden's description of the essential features of defendants' quick-action triple valve is limited, but correct.

567 It is correct in that the triple-valve functions, common in the art prior to 1887, which he has described as the functions of "*the triple valve proper*," are essentials.

It is correct in that he has dominated "*the differential passages*" as essentials, which they are as I have described in a previous answer, and not only are they essentials to defendants' quick-action triple valve, but likewise are they essentials, and similarly do they exist, in all other quick-action triple valves with which I am familiar.

Mr. Boyden's answer is limited, in that it does not describe the primary essentials of the defendants' quick-action triple valve. These priimary essentials, in addition to the other primary essentials, which Mr. Boyden has properly described, namely, the functions of "*the triple valve proper*," are as follows:

Sufficient parts, valves, ports and passages to enable the performance of the auxiliary or fourth function of quick-action triple valve by the further traverse of the piston of the triple valve, brought about by a further reduction of pressure in the train-pipe, both the said traverse and the further reduction being over and above that necessary to perform the three functions of the "*triple valve proper*," and further:

The essential check-valve which will prevent the return of pressure from the brake-cylinder to the train-pipe after it has entered from the train-pipe.

Having answered this question, I wish to explain further my answer to the previous question in that part referring to the meaning which is implied to me by Mr. Boyden's use of the term "additional." I have said that I have read Mr. Boyden's testimony in this case, and I now quote from (D. R.) page 30, folios 117–118:

"This distinctly shows that the complainants' device uses two valves to perform the quick application of the brakes, one of which belongs *to the triple valve proper* while the other is an auxiliary *valve additional* to the triple-valve structure."

568 From this I have been led to infer that Mr. Boyden used the term "additional," in the sense of being separated, as being an essential feature or characteristic of the device described in the specification of patent 360,070.

669 Q. Please state briefly what you understand to be the "essential features" of defendants' quick-action triple valve, plate IX defendants' 1889 catalogue, so far as the same may differ, if at all, from those of the structure of plate XI defendants' 1891 catalogue as indicated in your last preceding answer?

A. The description I have given of the essential features of defendants' quick-action triple valve, 1891 catalogue, applies with equal force, and without limitation, to the quick-action triple valve of defendants' 1889 catalogue.

670 Q. As a practical expert in quick-action automatic brakes, state to what extent you find the essential features of practical operation of defendants' quick-action triple valve (plate IX defendants' 1889 catalogue, and plate XI defendants' 1891 catalogue) to be in correspondence with those of the quick-action triple valve of patent 360,070?

A. In each of the three triple valves, there is a piston which is operated by momentary or continuous differential pressures, and which has two distinct traverses. The first traverse operates a set of parts, ports, and passages which perform the three functions of triple valves known in the art prior to 1887.

The second, or further, traverse, of the triple-valve piston, operates a set of parts, ports, and passages which perform the auxiliary or fourth function of quick-action triple valves, namely, quick action.

In each of the three triple valves there are differential passages, which render momentary or continuous differential pressures possible, and there are differential passages which restrict the flow of air from the auxiliary reservoir to the brake-cylinder, to prevent the filling of the brake-cylinder quickly by air from the auxiliary reservoir, and permit the quick filling of the
569 brake-cylinder by air from the train-pipe, through the much larger passage, for the performance of quick action. The passage from the train-pipe to the brake-cylinder is, in all three valves, enormously larger than the passage from the auxiliary reservoir to the brake-cylinder, for the sole purpose of rendering quick action possible.

In each of the three valves there is a check-valve, so located as to prevent the return of the air that has passed into the brake-cylinder from the train-pipe, to the train-pipe.

In each of the three valves, the further traverse of the piston, before mentioned, opens an auxiliary valve and permits the air from the train-pipe to flow through a large passage from the train-pipe to the brake-cylinder to produce quick action.

I have referred to the wide difference in the size of the differential passages used in triple valves, and more especially in quick-action triple valves, for the reason that quick action is dependent not upon the mere passage *per se*, of air from the train-pipe to the brake-cylinder, for this does not necessarily give quick action. Quick action is only possible when the passage from the auxiliary reservoir to the brake-cylinder is restricted (and thereby made differential with respect to the passage from the train-pipe to the brake-cylinder), so much as to prevent the flow of air pressure from the auxiliary reservoir to the brake-cylinder, in a sufficient quantity to suffocate and suppress a very material and substantial and rapid and early flow of air pressure from the train-pipe to the brake-cylinder, in such a way as to perform the three useful results of quick action, namely:

(*a*) To apply the brakes with greater force than they can be applied with auxiliary reservoir pressure.

(*b*) To so quickly and substantially reduce the pressure in the train-pipe as to cause the succeeding triple valves in the train to apply with quick action.

570 (*c*) To economize the air pressure stored in the brake system.

A more specific and detailed comparison of these three quick-action triple valves is as follows:

In order to shorten the following comparison I will refer to the three quick-action triple valves as follows:

Complainants' quick-action triple valve, shown and described in patent 360,070, I will denominate complainants' valve.

Defendants' quick-action triple valve, plate IX, 1889 catalogue, I will denominate defendants' 1889 valve.

Defendants' quick-action triple valve, plate XI, 1891 catalogue, I will denominate defendants' 1891 valve.

In each there is a triple-valve piston, having two distinct traverses, one traverse being an extension of the other, as follows: Piston 12, complainants' valve; piston 5, defendants' 1889 valve; piston 29, defendants' 1891 valve.

In each there is a combination of parts, valves and passages which perform, during the preliminary traverse of the triple-valve piston, the three functions of triple valves known in the art prior to 1887, as follows:

Stem 13, valve 14, valve 29, passage 31, cavity 33, complainants' valve.

Stem 13, stem 17, valve 18, valve 13 of defendants' 1889 valve.

Valve and stem 18, and the passages to that stem, and valve 17 of defendants' 1891 valve.

The foregoing parts perform the same function in each of the valves, and are actuated in the same way, namely, by the preliminary traverse of the piston, and, as they perform the same function, I shall denominate these parts as being those that perform the same function, and which have been described by other witnesses in this case, as I learn from reading the testimony with reference to complainants' valve, namely, the main valve functions.

There is a difference in the structure of the valves, as follows:

571 Valve 14 of complainants' valve is what is known as a slide-valve, while its equivalent, (valve 18) in defendants' 1891 valve, is a piston valve. The difference in structure does not give a difference in function. In the mechanical arts, piston valves and slide-valves are used interchangeably.

In each there are differential passages as follows:

The smaller 35 and the larger 42 of complainants' valve; the smaller passage *e* and the larger passage, that uncovered by valve 15, of defendants' 1889 valve; the smaller passage B, and the larger, that uncovered by valve 22, of defendants' 1891 valve.

In each the further traverse of the piston moves an auxiliary valve which opens the larger of the differential passages to the brake-cylinder from the train-pipe, as follows:

Valve 41 and passage 42, of complainants' valve; valve 15 and the passage which it opens, of defendants' 1889 valve; valve 22 and the passage which it opens, of defendants' 1891 valve.

In each, there is a check-valve which prevents the return of the air in the brake-cylinder to the train-pipe, as follows:

Check-valve 49, of complainants' valve; check-valve 11, of defendants' 1889 valve; and check-valve 26, of defendants' 1891 valve.

In complainants' valve and in defendants' 1891 valve, the auxiliary valves for the performance of the quick-action function are shown in the drawings to be non-integral with the piston, and do not move during the preliminary traverse of the piston, but in defendants' 1889 valve, the auxiliary valve for performing the quick-action function is integral with the piston. But, as I have said before, it is my opinion that this difference is immaterial. What is essential is, that the auxiliary valve for the performance of the auxiliary or fourth function of quick-action triple valves, shall be operated to perform that function, upon the further traverse of the triple-valve piston.

572 671 Q. In your last preceding answer, you have recited a number of essential features of practical operation of the defendants' 1889 and 1891 quick-action triple valves, which are in correspondence with those of the quick-action triple valve of patent 360,070.

Are we to understand that the features which you have named are *all* the essential features, which, in your opinion, exist in the several valves, and if not, what others are there, and are such others, if any, in correspondence or not?

A. I have described all the essential features of the three valves for the performance of the function of quick-action triple valves. Such other differences as exist are structural differences, which do not affect the practical operation of the valves.

672 Q. In his answer to Q. 12, defendants' witness J. B. Church alleges that there is a difference "in principle or mode of operation" between the device of patent 360,070 and the defendants' device.

Inasmuch as it appears from the cross-examination of Mr. Church

POOR COPY

that he has had neither a practical mechanical training nor a technical education, and testifies on the basis of his reading and studying in the Patent Office, it seems desirable, for the enlightenment of the court, that the opinions and theories he enunciates should be tested, as to their correctness, by one who is able to approach the subject from a *practical* standpoint.

To this end, please state whether the above-referred-to assertion of Mr. Church is correct or well founded, and if it is not, state what you, as a mechanical engineer familiar with air-brake practice, understand to be the "principle" or "mode of operation" of the appliance of patent 360,070, and state in what, if any, particular, either of "principle" or "mode of operation" the defendants' quick-action triple valves differ from the appliance of patent 360,070?

A. Mr. Church says:

"The patentee, Mr. Westinghouse, took the old-fashioned
573 valve, contrived *an additional valve element*, and compelled
the triple valve to actuate this additional valve element so that the latter would admit train-pipe air to the brake-cylinder under certain conditions."

This statement is incorrect in the use of the indefinite term "additional," and is limited very much by the use of the words, "under certain conditions."

A true statement of facts is as follows:

Mr. Westinghouse added to the triple valves in use prior to 1887, not an "*additional valve element*," but an additional function, namely, that of quick action, not the mere admission, *per se*, of train pipe air to the brake-cylinder, but the admission of train-pipe air to the brake-cylinder in such a manner as to perform quick action. In a preceding answer, I have tried to set forth the difference between the admission, *per se*, of air to the brake-cylinder from the train-pipe, and the admission in a manner which will perform quick action. The difference is distinct and marked; one produces a practical and useful result in the art of braking, namely, that of quick action, while the mere admission, *per se*, of air to the brake-cylinder does not necessarily produce any useful result. In fact, the admission of air from the train-pipe to the brake-cylinder, as done prior to 1887, did not produce a useful result, and such admission was not used, to my knowledge, to any extent in practical braking. As an example of the admission of air from the train-pipe to the brake-cylinder which will not produce quick action, and which will not produce a useful result, I will cite the device shown in patent No. 280,285, the operation of which is as follows, (see Fig. 3, patent granted to C. A. Boyden, June 26, 1883):

The auxiliary reservoir and the train-pipe, and the cavity L, which acts as a supplemental auxiliary reservoir, having been charged with, say, 70 pounds pressure, a reduction in the train-pipe pressure is not followed by a corresponding reduction in pressure
in the reservoir L, owing to the presence of a check-valve
574 d^1, which prevents a return of air through that charging
valve to the train-pipe. Therefore, there is established a differential pressure, and the piston I moves downward and opens

the passage C^1 to the brake-cylinder. Air then flows from the auxiliary reservoir to the brake-cylinder, through the passages R^1, C^1, until the pressure is reduced in the auxiliary reservoir, and in the triple-valve cavity, below what it is in the train-pipe. Then air passes from the train-pipe, through the charging valve d^1, into the triple-valve cavity, thence to the auxiliary reservoir through the passage R, and to the brake-cylinder through the passage C^1, until an equilibrium is established. There may be a slight difference, at the termination of this action, between the pressure in the auxiliary reservoir and the brake-cylinder and the train-pipe, owing to the presence of a small spring d^5 above the check-valve.

The inventor describes the purpose of this admission of air from the train-pipe to the brake-cylinder as follows:

"My invention consists, first, in the several combinations, hereinafter specified, with an air reservoir on the car, of means whereby the said air reservoir may be replenished or recharged with compressed air while the passages or ports leading therefrom from the brake-cylinder are open and while the brakes are applied."

"Fourth, in a new method of applying and maintaining the application of the brakes through a single line of train-pipe."

There may be other examples in the art, but I have cited this as a good illustration of how air pressure may be taken from the train-pipe, and admitted to the brake-cylinder, without producing quick action, or, in fact, any useful result whatsoever. The non-utility of the device shown in patent No. 280,285 appears to me from
575 the fact that I do not see any means provided for graduation, or that would produce a practical control of the amount of the pressure in the brake-cylinders.

Therefore, Mr. Church is not only limiting the improvement in the art of braking devised by Mr. Westinghouse, but he is incorrect in using the indefinite term "additional," when the specification of patent 360,070 distinctly uses the term "auxiliary." It is practically incorrect to omit to state the entire fact.

Mr. Church says:

"On the other hand, Mr. Boyden, the inventor of the defendants' device, took the form of the old-fashioned triple valve, which had a check-valved feed-passage, and by simply separating the piston chamber from the valve chamber and restricting the passage through which air flows from the auxiliary reservoir to the valve chamber, he introduced the new principle of 'momentary differential air pressures,' and thereby compelled the *triple valve itself* to admit train-pipe air to the brake-cylinder without the aid of any auxiliary-valve element whatever."

In the last sentence of the preceding quotation Mr. Church has used the correct term for describing the improvement devised by Mr. Westinghouse in the matter of construction, namely, the "auxiliary-valve element."

It is of course impossible for me to determine what Mr. Boyden "took" to form the defendants' triple valves; I can only understand what has been done, and that I find in the result of Mr. Boyden's work, namely, the defendants' triple valves. It is wholly un-

POOR COPY

safe for me to reason, or any one else for that matter, on the steps taken in development, and I will confine myself wholly to the results.

In defendants' 1889 and 1891 valves, I find what Mr. Church has described as a "check-valve" passage. But it is not essentially a "feed-passage." It is a large and substantial passage, alto-
576 gether too capacious for feeding purposes. I find it to be, primarily, for the purpose of admitting air from the train-pipe to the brake-cylinder, and the check-valve to be for the purpose of preventing the return of that air. Manifestly, passage F is all out of proportion to passage B, through which the air must flow to reach the auxiliary reservoir. Passage B would control the amount of air fed to the auxiliary reservoir, not valve 26 of defendants' 1891 valve.

The separation of the piston chamber from the valve chamber is not clear to me. The separation is not complete. A ring has been provided which acts, during quick action, as a restriction to the passage of air from the auxiliary reservoir to the brake-cylinder, but during the performance of the three triple-valve functions, there is practically no restriction brought about by this ring, and it might, for all intents and purposes of practical operation, be removed.

To be more specific, the ring that I have referred to is No. 9 of defendants' 1891 valve, and there is a similar ring in the 1889 valve. The passage B, 1891 valve, is so much larger than the passage to the brake-cylinder through the valve 18, that the air supply to the passage B, during the performance of the three triple-valve functions, is more than could pass through the passage to the brake-cylinder in valve 18, and, therefore, the ring 9 performs no useful purpose, during the operation of the quick-action triple valve as a plain triple valve prior to 1887. This I have found by experiment.

Although the passage B in the 1891 valve is larger than the passage to the brake-cylinder through valve 18, yet it is noticeable that the corresponding passage *e* of the 1889 valve is considerably smaller than the passage to the brake-cylinder controlled by valve 13. It is clear then, that the passage controlled by valve 13 to the brake-cylinder is more than ample to transmit all of the air that can pass from the auxiliary reservoir to the brake-cylinder through the passage *e* of defendants' 1889 valve.

577 The separation of the piston chamber from the valve chamber, in defendants' valve is, therefore, of no value to assist in performing the three triple-valve functions, but is of value to assist in performing the fourth, or quick-action, function, as it establishes a restricted passage, corresponding to the restricted passage 35 of patent 360,070, between the auxiliary reservoir and the brake-cylinder, which is provided in order to render quick action a possibility, as I have described in a preceding answer.

Adjourned to Thursday, January 4, 1894, at 11 a. m.

NEW YORK, *January* 4, 1894—11 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of D. L. BARNES resumed:

(A. to Q. 672 continued.) The restricted passage 35 of complainants' valve, and the restricted passage *e*, of defendants' 1889 valve, and B, of defendants' 1891 valve, are identical in purpose and function.

The large passage 42, of complainants' valve, and the large passages uncovered by valve 15, of defendants' 1889 valve, and valve 22, of defendants' 1891 valve, are identical in purpose and function.

The passages just described form the essential differential passages. Passage A, of defendants' 1891 valve, and passage *b*, of defendants' 1889 valve, are not passages which require any specific differential from passages B, (*e*). It is only necessary that the passages A (*b*) shall be large enough to furnish an ample supply of air, back of the triple-valve piston, just as is the case with complainants' valve, where a sufficient volume of reservoir air passes through the passage at the centre of the valve, on the left in figure 2.

578 Restricted passages for the purpose of producing "momentary" or continuous differential pressure are very old in the art of braking. Manifestly, if all the passages leading into and out of a valve were of the same size and capacity, it would be impossible to produce a momentary or continuous differential pressure. An example of restricted passages for the purpose of producing momentary differential pressures is found in several early patents for triple valves. For instance, patent No. 168,359, granted to George Westinghouse, Jr., October 5, 1875. There is a large passage R, figure 1, leading from the reservoir to the back of the triple-valve piston, and a small passage *s*, leading from the back of the triple-valve piston to the front or train-pipe side. These passages are differential in size, the passage *s* being restricted to give a differential pressure on opposite sides of the piston. Upon a substantial reduction of pressure in the train-pipe, the pressure on the train-pipe side of the piston is reduced, while the pressure on the opposite sides of the piston is maintained by an abundant supply of air through the large hole R, and is restricted from quickly increasing the pressure on the train-pipe side of the piston through the restricted passage *s*, because of the differential size of the passages *s* and R. This gives, therefore, a differential momentary or continuous pressure on the opposite sides of the piston, for the purpose of operating the piston.

Mr. Church is entirely wrong in saying, that Mr. Boyden has introduced the "*new* principle of momentary differential air pressure." The principle is very old in the art.

Mr. Church is not right in intimating that the check-valved feed-passage remains in defendants' 1891 valve, as a feed-passage, *per se*, as the only relation it bears to a feed-passage, in the present construction, is that the feed passes through it, and is not controlled by it. It has been found necessary, in practical operation, to con-

trol the feed or charging process by small grooves in the
579 stem of piston 29, the area of these grooves being exceedingly small, probably about one two-hundredths part of the area of the passage F, defendants' 1891 valve, which Mr. Church has intimated is a "check-valved feed-passage."

Mr. Church omitted to say that the passage F, which I understand he has termed the "check-valved feed-passage," has its main and only practical purpose and function in admitting train-pipe air to the passage uncovered by valve 22, upon the further traverse of the piston.

Mr. Church says that Mr. Boyden "compelled the *triple valve itself* to admit train-pipe air to the brake-cylinder without the aid of any auxiliary-valve element whatever."

In this Mr. Church is entirely wrong, for two reasons, as follows:

(*a*) Auxiliary-valve elements are added, namely, restricted passage B, valve 22 and valve 26.

I understand the term "auxiliary-valve element" to mean any element which goes to make up a valve, whether it be a port, a passage, a valve, a piston, or a function, or office.

(*b*) If, in any piece of mechanism, the parts be rearranged, enlarged, reduced, changed, separated, or made more integral, so that one part performs the office of two or more others, such change adds a valve element or function, if another function or office is performed. It does not decrease the number of functions of a mechanism if the individual parts are combined in a different way, or combined to make a less number of parts, provided the same functions are performed.

I cannot find a single function that is performed by the complainants' valve, that is not also performed by the defendants' valves, and furthermore, they are performed in substantially the same way. In this conclusion I am upheld by the statement in defendants' catalogue 1891 (p. 29), which sets forth the operation of defendants' valve as follows:

580 "The actions of this valve in graduating, full-service application, quick action and the release, are the same as the new Westinghouse quick-action valve, thereby producing the same results in braking, which renders cars equipped with the two valves perfectly interchangeable—the hose couplings being the same."

Mr. Church says:

"In admitting train-pipe air to the brake cylinder the device of Mr. Westinghouse acts on the mechanical principle of employing the triple-valve piston to actuate a new and additional valve element to open the passage from the train-pipe to the brake-cylinder: whereas, the device of Mr. Boyden acts on the entirely different mechanical principle of employing *differential air pressures* to actuate, not a new and additional valve element, but *the triple valve* itself, to open the passage from the train-pipe to the brake-cylinder."

Mr. Church is wrong in this statement, for the specification of patent 360,070 distinctly defines the new principle devised by Mr. Westinghouse, which is the employment of the further traverse of the triple-valve piston to actuate an auxiliary valve, which may, or

may not, be a part and parcel, or integral with, any other valve or part, but what it must be is, auxiliary in its function. The term "additional" used by Mr. Church is unwarranted.

Mr. Church is wrong in saying that the defendants' valves operate on the "entirely different mechanical principle of employing *differential air pressures*," for the reason that this is not a different principle from what has been employed in triple valves from the beginning of their use so far as I know. Without "differential air pressures," the complainants' valve could not operate either as a triple valve prior to 1887, or as a quick-action triple valve. I have found, from actual experience, that one of the most important

581 features to provide for, in designing plain triples or quick-action triple valves, is the "differential air pressures," which Mr. Church has called a "different mechanical principle." The whole foundation of useful practical operation of quick-action triple valves rests on the possibility of obtaining the necessary differential air pressures.

Mr. Church says that Mr. Boyden uses "*the triple valve* itself, to open the passage from the train-pipe to the brake-cylinder." This is not new, and is exactly what is done in complainants' valve. The triple-valve piston is a part of "the triple valve itself," and it is the further traverse of this piston which is used, in both the complainants' and defendants' valves, "to open the passage from the train-pipe to the brake-cylinder."

Mr. Church says:

"Mr. Westinghouse uses a new and auxiliary valve, not a part of the triple valve. Mr. Boyden utilizes the feed-valve of the old triple valve."

Mr. Church is wrong in this, because the specification of patent 360,070 in no way refers to the necessary use of a "new and auxiliary valve, not a part of the triple valve." Mr. Westinghouse devised a quick-action triple valve not known in the art prior to 1887, in which there is an *auxiliary* valve operated by the further traverse of the piston, which *auxiliary* valve may, or may not, be a part and parcel with any other part of any triple-valve construction known prior to 1887, but what it must have is, the *auxiliary function* of admitting air from the train-pipe to the brake-cylinder, upon a further traverse of the triple-valve piston.

Mr. Church is wrong in saying that "Mr. Boyden utilizes the feed-valve of the old triple valve," for any such purpose as Mr. Westinghouse has used the auxiliary valve. Mr. Westinghouse's auxiliary valve performs the auxiliary function of admitting air from the train-pipe to the brake-cylinder, which is an entirely

582 different operation from that performed by the feed-valve in the present construction of defendants' valves. The feed-valve, or that part which controls the feed, is an exceedingly small groove in the piston stem, and this feed valve or groove admits air from the train-pipe to the auxiliary reservoir, which is an entirely different operation.

In the preceding portion of this answer, I have cited an example (namely, G. A. Boyden, patent No. 280,285, June 26, 1883), of a

triple valve having a passage from the train-pipe to the brake-cylinder, which performs no useful purpose in the application of the brakes by train-pipe pressure. That triple valve has "a check-valved feed-passage" of the kind that I understand Mr. Church refers to, but if this is what he means, I cannot see the logic which leads him to intimate that defendants' 1889 and 1891 valves are the same in any essential feature, either in construction or in operation, but of course I can understand that, in the light of the development of the art shown in the drawings and specification of patent 360,070, an intelligent mechanic might change, alter, and develop a device like that shown in patent No. 280,285, using at the same time the experience obtained in the art with plain triple valves prior to 1887, to such an extent as to make a quick-action valve, but, as the device shown in patent No. 280,285 is not a practical and useful plain triple valve, and has no essential element of a quick-action triple valve, it is evident that the changes necessary to produce a quick-action triple valve operating practically like complainants' valve, as claimed in defendants' 1891 catalogue, page 29, from which I have quoted, would be sweeping and would produce an entirely different structure, producing entirely different results. And this I find to be the case when I compare defendants' 1889 and 1891 valves with defendants' valve shown in patent No. 280,285.

If this is the sort of comparison that Mr. Church intends
583 to make when he says that "Mr. Boyden utilizes the feed-valve of the old triple valve," then he is entirely wrong and illogical.

Mr. Church says:

"Mr. Westinghouse actuates his new valve by the impact of the triple-valve piston."

But Mr. Church omits to say that the defendants actuate their new valve for producing the auxiliary or fourth function, by the impact of the piston, in precisely the same way, and upon the further traverse of that piston.

To be more specific, the impact of the collar on the piston stem of defendants' valves is what lifts or opens the auxiliary valve 22 and performs the fourth function, namely, quick action.

Mr. Church says that

"Mr. Boyden actuates the old feed-valve, such as that of his 1883 patent, by the differential air pressures momentarily established in the triple-valve chamber."

I do not see what this statement has to do with the case in point, as the old feed-valve of the "1883 patent" is not present in the construction of defendants' valves. I do find there present a check-valve through which the feed of air passes, but that check-valve is not used for the purpose, at the present time, of controlling the feed in defendants' valves, but is used for, and finds its main usefulness in, preventing the return of air to the train-pipe from the brake-cylinder after the train-pipe air has passed to the brake-cylinder.

Mr. Church is wrong in intimating that there is anything new in the art, in operating check-valves to assist in quick-action, or feed-check valves to control the charging process, by the "differential

pressures momentarily established in the triple-valve chamber," for the reasons which I will now recite:

584 In patent No. 280,285, to which I have before referred, the feed-check valve is operated like all other "check" valves with which I am familiar, by differential pressures, and, in this case, by "the differential air pressures momentarily established in the triple-valve chamber."

In a preceding answer I have called attention to the fact that the passage B (*e*) has no office or usefulness except in the performance of quick action. This statement has an important bearing, in this way. When valve 22 (15) is opened, the pressure in the cavity C of the 1891 valve, and the corresponding cavity in the 1889 valve, becomes the same as that in the brake-cylinder for the moment, and for all purposes of practical operation, that cavity, namely, C, during quick action, might just as well be a part of the cylinder, and is, in fact, a part of the cylinder cavity, for all the purposes of quick action. Bearing this in mind, it is seen that as soon as valve 22 (15) is opened, the pressure in cavity C is identical with that in the brake-cylinder.

Hence, the momentary condition at the commencement of quick action, with respect to check-valve 26, which is a check-valve of the kind now being considered, is as follows:

On the brake-cylinder side there is brake-cylinder pressure, which is practically atmospheric pressure, and on the train-pipe side there is train pipe pressure; hence there is established a momentary differential pressure between the brake-cylinder pressure and the train-pipe pressure, which opens check-valve 26.

An exactly parallel case is found prior in the art in the case of complainants' valve, patent 360,070 to which I now refer, Figs. 2 and 4. At the commencement of quick action, check-valve 49 is exposed on one side to brake-cylinder pressure, and on the other side to train-pipe pressure, for reasons that are perfectly clear from the construction. Hence the momentary conditions at the

585 commencement of quick action, with respect to check-valve 49, which is a check-valve of the kind now being considered, are as follows:

On the brake-cylinder side, there is brake-cylinder pressure, which is practically atmospheric pressure, and, on the train-pipe side, there is train-pipe pressure; hence there is established a momentary differential pressure between the brake-cylinder pressure and the train-pipe pressure, which opens check-valve 49, in precisely the same way as check-valve 26 is opened in defendants' valves.

It is misleading and indefinite to refer to "triple-valve chambers" as Mr. Church has done, for the reason that there are, and may be, several triple-valve chambers, which may be confused with each other. For instance, if we should compare triple-valve chambers like other details of compound valves, on the basis of their function, and distinguish these functions by the pressures contained in the triple-valve chambers at coincident times, we should find some of the chambers having different functions at

different times, which lead to confusion. For instance, in complainants' triple valve of patent 360,070, the chamber below the piston 12 has practically the same pressures at coincident times, as the chamber below piston 29 of defendants' valves.

The chamber above piston 12, of complainants' valve of patent 360,070, has practically the same pressures at coincident times as the chamber above piston 29, and between it and the passage B, of defendants' valves.

In defendants' valves, there is a chamber C which has a wide variation in pressure therein, and, at one time, is practically a part of the brake-cylinder cavity, by reason of the opening of the large passage by valve 22, which is the case during and after quick action has taken place, while, at another time, namely, during the performance of the three triple-valve functions, the passage B becomes *nil*, for all practical purposes, and the cavity C is then
586 practically a part of the auxiliary reservoir. Thus the cavity
C alternates, from being a part of the brake-cylinder during and after quick action has taken place, to being a part of the auxiliary reservoir cavity during the performance of the three triple-valve functions.

There is no "*the*" triple-valve cavity, *per se*, which is sufficiently definite to make a comparison based on such a "*the*" cavity safe for reaching two conclusions.

In this case, the question involved is, what actuates the check-valve which prevents the return of train-pipe air to the train pipe after it has passed to the brake-cylinder. Clearly it is, as I have shown, that it is accomplished "by the differential air pressure momentarily established" (not *in the triple-valve chamber*) between the brake-cylinder pressure on one side of the check-valve, and the train-pipe pressure on the other side.

Mr. Church says:

"Suppress the auxiliary valve 41, and the port 42 of the Westinghouse device, and there can be no quick action nor admission of the train-pipe air directly into the brake-cylinder, although the triple valve will, in other respects, act as before; suppress the partition 9 in the Boyden device, and there can be no quick action nor admission of train-pipe air directly into the brake-cylinder, although the triple valve will, in all other respects, act as before."

This much of Mr. Church's statement about suppression of parts is true, as it is a statement of fact, but he might have added that there are many other parts which, if suppressed, would result in destroying quick action, but, although the suppression of any one of several of the parts of the two valves being considered, would destroy quick action, thus producing the same practical result, the production of the same practical result does not make them equivalent.

A practical example might be found in the case of a window
587 pane; a brick and a bootjack will both break window panes
and thereby produce the same result, but this does not prove

that a brick is equivalent, or the same thing as, or that it has the same functions as, a bootjack.

Mr. Church is entirely wrong in drawing a comparison between the office and function of devices, simply because the suppression of them will produce a sweeping destructive result. Take the case in point; Mr. Church says:

"In the one case (Westinghouse device), therefore, the auxiliary valve 41 and its port 42 constitute the quick-action device as distinguished from the old triple valve; in the other case (Boyden device), the partition 9 and its restricted passage *e* (or B) constitute the quick-action device as distinguished from the old triple valve."

The error in such a comparison I will now point out by an example from the two devices in question, in which I will make a comparison between two parts, the suppression of which will destroy quick action, and yet which are manifestly not the equivalents of each other in any respect.

I will assume that the small projection on the bottom of piston 12 of complainants' device be removed or suppressed, and that the auxiliary valve 22 of defendants' device be removed or suppressed. In both cases quick action will be destroyed, but, manifestly, the hub on the piston 12 is not the equivalent of the auxiliary valve 22, which shows the illogical comparison used by Mr. Church to prove the equivalence of devices in the valves in question.

I will now make a comparison that is more logical, following Mr. Church's plan of suppression otherwise, but in this comparison I shall suppress equivalent devices, and not non-equivalent.

If the valve 41 and passage 42, of complainants' device, and valve 22 of defendants' device, and the passage which it controls
588 be suppressed; quick action will be destroyed, and the devices are equivalent, *because there will then be no passage of ample size from the train-pipe to the brake-cylinder and no auxiliary valve to open such passage upon the further traverse of the triple-valve piston.*

I will assume that the partition 9, and its restricted passage *e* (or B) of defendants' valve, and the restricted passage 35 of complainants' valve be suppressed; quick action will be destroyed and the devices are equivalent, *because there will then be no restricted passage between the auxiliary reservoir and the brake-cylinder to prevent the auxiliary reservoir pressure from quickly filling the brake-cylinder, thus reducing the amount of air which can enter from the train-pipe below a point where quick action will be produced.*

If the check-valve 49 of complainants' valve, and the check-valve 26 of defendants' valves be suppressed, quick action will be destroyed *because there will then be no "check" to the return of air from the brake-cylinder to the train-pipe; thus the practical effect and useful result of quick action will be lost.*

If the further traverse of the piston 12 of complainants' device, and the further traverse of piston 29 of defendants' device be suppressed, there would be no quick action *because there would then be nothing to operate and actuate the auxiliary valves (41 and 22 respect-*

POOR COPY

ively) which open the passage directly from the train-pipe to the brake-cylinder to perform the auxiliary or fourth function.

If the "impact" of the triple-valve piston 12, through its hub, on the auxiliary-valve device of complainants' valve, and the impact of the triple-valve piston 29, through the collar on its stem, be suppressed, there would then be no quick action *because there would then be no means of actuating the auxiliary-valve devices upon the further traverse of the piston.*

The foregoing comparisons are logical, for the reason that the *causes* which, in each case, destroy the quick action, are shown to be the same in both. In omitting to give the causes which
589 lead to the identical result, Mr. Church has been led into making comparisons between devices that do not perform the same function, and are therefore incomparable.

The error in the following statement by Mr. Church, is too apparent to need further explanation than that I have already given. He reasoned to the conclusion that the devices have a "difference of principle" which is fundamental, and "completely distinguishing" the one from the other; that they have "no common analogy or resemblance;" that it is "necessary to assign the two inventions to entirely different classes or catagories when looked at from a mechanical point of view."

In this Mr. Church is wholly wrong. The devices differ only structurally, and not at all functionally, and not at all in the methods employed to perform the functions.

To sum up, and state concisely what I have said at more length in answer to this question, I now say the following:

1st. Mr. Church's statement is not correct or well founded.

2d. The "principle" or "mode of operation" of the appliance of patent 360,070 is as follows:

(*a*) The performance of the three triple-valve functions common in the art prior to 1887.

(*b*) The admission of train-pipe pressure from the train-pipe to the brake-cylinder, brought about by the further traverse of the triple-valve piston, which actuates an auxiliary valve to perform the auxiliary or fourth or quick-action function, which auxiliary valve may be either integral or non-integral, according to convenience of construction.

(*c*) The utilization of a check-valve, to prevent the return of air pressure from the brake-cylinder to the train-pipe, after the train-pipe air has entered that cylinder.

3d. There is no difference either of "principle" or "mode of operation" between the complainants' and defendants' quick-action triple valves.

590 Counsel for defendants objects to this last answer because:

First, it is really not evidence, but in large part, is a specious and labored argument of the witness.

Second, because the last question was addressed to the witness "as a mechanical engineer familiar with air-brake practice," while much of the answer assumes to expound and explain patent No.

360,070 itself; the answer therefore is the testimony of a patent expert, for which the witness has shown no qualification.

Third, the answer is objected to because the question called for the witness' understanding of the "principle" or "mode of operation" of the appliance of patent 360,070, and in what particular the defendants' valves differ therefrom, while the witness, pretending to answer this question only, has in fact volunteered a long argument, much of which is about matter not called for in the question.

In reply to the foregoing objection of defendants' counsel, counsel for complainants respectfully submits to the court, that, as defendants' record will show, the witness J. B. Church, a so-called "patent expert" is a mere theorist, having no practical mechanical training or experience whatever, and that in his answer 12, as to the correctness of which this witness was interrogated, he has, in support of his allegation that there is a difference "in principle or mode of operation" between the defendants' and complainants' devices, not only made a number of statements of alleged matters of fact, but has also offered an argument, which it is submitted is quite as fully open to the charge of being "specious and labored" as any statements made by this witness can possibly be. It is manifestly both competent and proper to offer the testimony of a mechanical

591 engineer familiar with air-brake practice, in refutation of, and reply to, the statements and arguments of defendants' so-called "patent expert," and equally proper that this witness, who speaks from a *practical* standpoint, shall give his reasons for the assertions he makes, as well as indicate to the court the misleading character of the pretended comparisons made by Mr. Church.

It is further submitted that this witness has not attempted "to expound and explain" anything, other than the construction and principle of operation of the device of patent 360,070, so far as he has referred to that patent, and it would certainly seem that a practical man, "a mechanical engineer familiar with air-brake practice," ought to be familiar with the "principle" or "mode of operation" of the appliance of patent 360,070, at least as fully as a mere theorist like Mr. Church, and that his expressions, with relation to such "principle" or "mode of operation," are fully within the scope of his qualifications, which it will be noted, do not include expounding the meaning and scope of patent claims, or the discussion of any other matters of law.

Counsel for defendants submits to the court that "a mechanical engineer familiar with air-brake practice," and who has shown no qualifications for explaining the scope of letters patent, should not assume to explain the scope of the specification of the patent in suit, simply because he refrains from testifying as to the scope of the claims of said patent.

To which counsel for complainants replies, that it would seem that the error of defendants' counsel, in making the objection that he has done, is due to the fact that he has failed to recognize that the specification and drawings of a patent constitute a technical description of an appliance, addressed to just such practical

592 men as the witness, and that if he is not able to understand,

and explain fully, all points relating to the construction and principle of operation of the appliance recited in such technical description, he is not a competent mechanical engineer. Defendants' counsel seems to confound the qualifications of the witness for dealing with this technical description, with other qualifications which he does not profess to have, namely, those of passing upon and discussing the scope and meaning of the claims of the patent, which are matters of law, with which the witness very properly and sensibly does not propose to meddle.

Counsel for defendants has objected to the testimony of the witness, for the purpose of calling the attention of the court to the fact, that, while the witness is avowedly refraining from expounding the claims of the patent, he is really endeavoring to make it appear that he gathers, from the specification of the patent, an interpretation and meaning not warranted. The court will discern in this the evident bias and unfairness of the witness.

673 Q. How far, if at all, do you find Mr. Boyden's statements on page 27 (D. R.) as to an alleged "fourth valve," and its supposed function, to be true and correct statements?

A. They are entirely incorrect, for the following reasons:

(*a*) Mr. Boyden has said that the valve port 35 is a main valve, which it is not, as it is not the valve "mainly" used in braking, and is only used in the performance of the emergency, quick action, or fourth function, of quick-action triple valves. The "main" valve is the valve 14, which performs, in triple valves, the "main" function of braking.

Adjourned to Friday, January 5, 1894, at 11 a. m.

593 NEW YORK, *January* 5, 1894—11 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of D. L. BARNES resumed:

A. to Q. 673 continued.

(*b*) Mr. Boyden has referred to "cut No. 5," complainants' device. Any reference to this cut is necessarily incomplete and incorrect, because it indicates that the complainants' device has a function which it doesn't have at all, namely, what Mr. Boyden has denominated "this function," "the above function," "fourth valve," "main valve, whose function." The impression is conveyed that this is a separate function, and that all of the function is described, whereas it is distinctly in error in the following points:

1st. The auxiliary valve 41 is open, and there is every condition present necessary for the admission of air from the train-pipe to the brake-cylinder through passage 43, but no such action is indicated on the cut. In point of fact, the positions of the parts are identical with those of drawing No. 7, and, therefore, the same function would be performed in the same way. For all the purposes of describing the quick-action function and the office of port 35, which

Mr. Boyden has denominated the "fourth valve," drawing No. 7 is competent, while drawing No. 5 is not.

2nd. Port 35, which Mr. Boyden has denominated the "fourth valve," cannot be brought into the position shown in cut 5, without the performance of the true fourth function of quick action triple valve, namely, quick action, and in the manner that is shown in drawing No. 7.

(*c*) The only function of port 35, its office and purpose, is the second function of triple valves prior to 1887, namely, that of admitting air from the auxiliary reservoir to the brake-cylinder.
594 It has no other function, and can have no other, as is manifest from its construction, and its location in relation to other parts.

(*d*) To show the function of port 35 to be the second function of triple valves prior to 1887, I will illustrate how port 35 can be entirely removed, and its function performed in the same way, to produce the same useful and practical results, by another port of triple valves prior to 1887, which has the same function. The addition of port 35 is a matter only of preference in construction, not of necessity.

I will now refer to "Complainants' Exhibit Westinghouse Modification:"

In this construction, port 35 has been absolutely removed, and no equivalent in structure has been substituted. The identical equivalent in function, is, in this arrangement, formed by an extension of the port opening of the port 31, which is manifestly the part which performs the second function of triple valves prior to 1887, and in this extension, marked *x*, and by it, no new function is performed, but only the same function of passage 31, namely, that of admitting air from the auxiliary reservoir to the brake-cylinder.

"Complainants' Exhibit Westinghouse Modification" is a perfectly practical construction, and will perform all the functions, namely, the three of triple valves prior to 1887, and the fourth, or quick-action, function of quick-action triple valves, and produce just as perfect practical results as "complainants' valve."

(*e*) Mr. Boyden has said, that when defendants' quick-action triple valves are performing the "above function," (which is, in fact, the second function of triple valves prior to 1887, for the obvious reason that he does not say that the quick-action function is being performed at the same time), "the air passes from the auxiliary reservoir through the ports A and B into the chamber C, then passes through the port uncovered by the valve 22 to the brake-cylinder, through the passage H," and refers to "cut No. 6." It is
595 obvious, from the construction of defendants' valve, and from the practical experiments which I have performed with defendants' valves, both at Wilmerding, and at Baltimore in the presence of Mr. Boyden, that defendants' valves cannot be operated in this way. To these experiments I will refer later in this answer.

Drawing No. 6 is in error, in that the check-valve 26, provided for the purpose of preventing the return of air from the brake-

cylinder to the train-pipe, is not shown opened when the piston has traveled to the limit of its stroke, it is as shown in drawing No. 6. Neither is it indicated that air is passing, or has passed, from the train-pipe to the brake-cylinder, as is manifest must be the case when the piston is in the position shown in drawing No. 6.

Drawing No. 8 shows the fact of operation, and, for all purposes of description of the function, of passage B, valve 22, check-valve 26, and the farther traverse of the piston, drawing No. 8 is competent and complete, while drawing No. 6 is wrong and incomplete.

(*f*) Valve 22 cannot be lifted from its seat to perform any useful function of braking, without the performance of the fourth or quick-action function, and without causing the check-valve 26 to assume the position shown in drawing No. 8.

(*g*) Drawings Nos. 5 and 6 are misleading and incorrect.

(*h*) I have shown, in a preceding answer, the equivalence of valve 14 of complainant's device, and valve 18, *i*, *k*, *j*, 17, 40, as it has been variously marked, of defendants' device, and that these valves perform the same functions, which are the "main" functions of braking, and, therefore, if there are any valves in these devices that are competent to be termed "main" valves, they are those that I have just referred to. As I have before explained, in a preceding answer, it is indefinite and unsafe to describe parts of compound valves, in any way except by referring to their functions. For this
596 reason, and others that I have given, it is indefinite and non-descriptive to use the term "fourth valve" and "main valve."

In conclusion, and for the reasons that I have set forth in detail, I find Mr. Boyden's statements on page 27 (D. R.) as to an alleged "fourth valve," and its supposed function, to be untrue and incorrect.

The experiments that I have referred to were made at Wilmerding by me November 6, 1893, and by Mr. Boyden, and witnessed by me, at Baltimore November 7, 1893. These experiments were as follows:

(*a*) Defendants' 1891 valve was operated as a quick-action triple valve, and it performed all the functions, namely, the four I have described, of complainants' valve, producing exactly the same results. The results were identical, in the same way as described in defendants' 1891 catalogue, page 29, which I now quote:

"The actions of this valve in graduating, full-service application, quick action and the release, are the same as the new Westinghouse quick-action valve, thereby producing the same results in braking, which renders the cars equipped with the two valves perfectly interchangeable—the hose couplings being the same."

The same results were exhibited by Mr. Boyden at Baltimore, and were witnessed by me.

(*b*) I attempted, by a rapid reduction of train-pipe pressure under the most favorable conditions, namely, with a short train-pipe, and with one valve, and with both a plain engineer's one-way valve and with an automatic engineer's valve, to pull the valve 22 off of its seat and admit auxiliary reservoir pressure through the port un-

BLEED. THROU

covered by valve 22, for the purpose of applying the single brake, and to apply that brake more quickly, but without quick action. This I could not do.

597 In Mr. Boyden's experiment at Baltimore, witnessed by me, I observed that the same results were obtained.

One point of importance here, and which further convinces me that valve 22 has no other office, in practical braking, than for the purpose of performing the fourth or quick-action function, is that defendants' 1891 catalogue, page 29, from which I have quoted in the foregoing, states that:

"The actions of this valve in graduating, full-service application, quick action and the release, are the same as the new Westinghouse quick-action valve, thereby producing the same results in braking."

When the brakes are applied with auxiliary reservoir pressure, if a large port, such as that opened by valve 22, should be opened between the auxiliary reservoir and the brake-cylinder, the results in braking would be disastrous and would cause severe and damaging shocks in a train. The complainants' device does not give any such results, which would follow from the opening of a large port, and neither does defendants' valve give any such result, as is set forth in the paragraph from defendants' 1891 catalogue, to which I have made reference, and, therefore, it is clear that, in practical braking, no large passage between the auxiliary reservoir and the brake-cylinder, like that uncovered by valve 22, is opened in the practical operation of defendants' valves.

(*c*) To further show the real office of valve 22, and to satisfy myself whether it was essential, or used practically to admit air from the auxiliary reservoir to the brake-cylinder for service application, I had valve 22 fixed to its seat, so that it could not be lifted. Now it is noticeable that the passage uncovered by valve 22, is vastly larger than passage B, through which all air must come from the auxiliary reservoir to reach the brake-cylinder, through the passage uncovered by valve 22; hence, so far as the relative
598 dimensions of valve 22, and the passage which it uncovers, are concerned, such large dimensions were provided for some other purpose than the admission of air to the brake-cylinder from the auxiliary reservoir. To determine whether a simple enlargement of the openings through the valve 18, which is manifestly a simpler and more practical construction than that of valve 22, which has a large flat seat liable to give trouble in practical operation, would transmit all the air from the auxiliary reservoir that could come through passage B, and thus permit the application of the brakes as quickly, by auxiliary reservoir pressure, as it could be applied through passage B, I had the holes through stem 18 enlarged, so that the combined area was greater than the area of passage B, and therefore, more air could be passed through the holes in stem 18 than through passage B. The result showed that, with this modification, namely, with valve 22 fixed to its seat, defendants' valves would graduate and apply the brakes as fully as they could be applied by auxiliary reservoir pressure through the passage B,

and this showed to me that the simpler construction of enlarging the holes through the stem 18 would perform all that the defendants have claimed to be performed by valve 22 in applying the brakes with auxiliary reservoir pressure, and from that I am led to believe that the valve 22, with its attendant mechanical difficulties in practical operation, and the increased number of parts and chances for leakage, and defects from sand and grit getting under its seat, was devised, not for the purpose of a quick-service application, as claimed, but because its presence is compelled in order to get a performance of the fourth, auxiliary, or quick-action function, namely, to admit air from the train-pipe to the brake-cylinder.

An experiment of this kind was not exhibited by Mr. Boyden at Baltimore.

(*d*) To determine the effect of a removal of a restricted passage between the auxiliary reservoir and the brake-cylinder, such
599 as passage B of defendants' valve, and passage 35 of complainants' valve, I had the ring 9 removed from defendants' valve, and found that, with this modification, quick action could not be obtained, *because the auxiliary reservoir pressure entering the chamber C, prevented the opening of check-valve 26 by the lower train-pipe pressure, when valve 22 was pulled off of its seat by the piston, (thus making the chamber C practically a part of the brake-cylinder cavity,) just the same as would be the case with complainants' device, if passage 35 was made a large and non-restricted passage, thus admitting a large volume of auxiliary reservoir air quickly to the brake-cylinder, which would prevent the opening of check-valve 49 by the lower train-pipe pressure when valve 41 was opened, (the chamber in which valve 49 is located being practically a part of the brake-cylinder cavity).*

In both these devices the pressure from the auxiliary reservoir, going quickly into the brake-cylinders, and reaching check-valve 49, would prevent their opening by the lower train-pipe pressure.

From the fact that the result of the suffocation of the two check-valves is the same, and is produced in the same way, namely, by the suppression of the restricted passages B and 35, I was led to the conviction that these restricted passages are equivalent and have the same office.

Test of this kind was performed by Mr. Boyden subsequently at Baltimore, and witnessed by me, and with the same result, and by these last tests I was not led to change my first conviction.

(*e*) In another experiment I had the hole in the stem 18 of defendants' valve plugged, so as to be inoperative. In this modification, valve 22 could be lifted from its seat, and by using great care with the short train-pipe, which is a favorable condition, I could make two applications from the auxiliary reservoir to the brake-cylinder, the first being an application of about 25 pounds in the brake-cylinder, the second being full application. Generally, however, whenever the valve 22 was lifted from its seat the brakes
600 were fully applied with auxiliary pressure. But, in order to perform this experiment, the restricted passage B had to be removed, which was done by removing the ring 9, otherwise, in every instance, without a single exception, quick action took place at once and fully whenever valve 22 was lifted from its seat. This

showed to me that *whenever valve 22 was used for the admission of auxiliary pressure reservoir to the brake-cylinder in combination with the restricted passage B, quick action invariably took place at once and completely. It is important to note, that at this time, all uncertainties as to how the auxiliary reservoir pressure was admitted to the brake-cylinder, were removed by the plugging of the holes through the stem 18; this compelled the auxiliary reservoir pressure to pass through the valve 22, and gave conditions that were free from any bias and uncertainty.*

In this experiment, if the capability, or the function, of valve 22, was to have enabled a quick application of the brakes with auxiliary reservoir pressure, without getting quick action, as claimed by the defendants, such result would have been accomplished as the conditions were most favorable, but such result was not accomplished, and by no special or "trick" manipulation, could I produce, by opening valve 22, the performance of anything but quick action.

The conditions were favorable to show the capability of valve 22, to perform what Mr. Boyden has termed, the function of the "fourth valve, main valve," for the following reasons:

1st. The plugging of the holes in the stem 18 prevented the admission of auxiliary reservoir pressure to the brake-cylinder, by way of those holes, and confined the admission of auxiliary reservoir pressure to the valve 22, thus giving that valve a full opportunity to exhibit its capability of admitting auxiliary reservoir pressure without giving quick action.

2d. The conditions were favorable, because the plugging of the holes in stem 18 permitted a quicker formation of a momen-
601 tary differential pressure on the opposite sides of the piston 29, because the air from the auxiliary reservoir, flowing into the back side of the piston, would not be reduced in pressure by being drawn through passage B and cavity C to the brake-cylinder, through the holes in the stem 18, as these holes were plugged.

3d. Only one brake-valve was used and the piping necessary for one car. This permitted a quick discharge of air from the train-pipe, and thus gave a more rapid formation of differential pressures on the opposite sides of the piston 29.

To further satisfy myself that the use of a short pipe and a single valve was more favorable to the operation of defendants' valve as claimed, by the admission of auxiliary reservoir pressure to the brake-cylinder through valve 22, without the performance of quick action, I performed an experiment with a triple valve having the three functions of triple valves prior to 1887, namely, a valve of the type shown in patent No. 220,556, granted to George Westinghouse, Jr., October 14, 1879, which was modified by increasing the performance of the second function of triple valves prior to 1887, namely, the admission of auxiliary reservoir pressure to the brake-cylinder by providing a larger opening of the passage C to the brake-cylinder. This gave a more forcible or quicker application of the auxiliary reservoir pressure to the brake-cylinder; when the port C was opened wider, and with one brake, there was a slight difference in the time of application, say about a quarter of a second, but,

with twenty-five brakes, I could not produce a larger opening of the passage C, and thereby get a greater degree of performance of the second function, on more than the first few brakes. This showed me three things:

1st. That a single brake and short piping was more favorable for the performance, in a higher degree, of the second function of a triple valve prior to 1887, and therefore showed that if valve 22 of defendants' valve could perform the second function of triple
602 valves prior to 1887, at all, it would be performed under the
conditions I had adopted for the experiment before cited in this answer, and under which condition it did not perform it as claimed by defendants.

2d. The experiment showed that there was no practical value in providing for a higher degree of performance of the second function on trains of practical length.

3d. The experiment showed that the front brakes of a practical train would apply quicker than the succeeding brakes in the train, and cause serious shocks and frighten passengers unnecessarily, throw down live stock, and cause a shifting of the freight in the cars, besides damaging the cars, all of which has been fully established by practical experiments with actual trains on railroads, more especially the experiments performed in 1886 and 1887, by a committee appointed by the Master Car Builders' Association, at Burlington, Iowa.

(*f*) At Baltimore Mr. Boyden showed an experiment which I witnessed, with a device similar to that shown in drawing No. 10 (D. R.)

The operation of this device, with all of the details present, as shown in the drawing, which make it a quick-action triple valve, having the four functions of practical operation, was identical with that of the complainants' device, with defendants' valves, and with the description of the operation of defendants' valve as given on page 29 of defendants' 1891 catalogue.

With the ring 9 removed, which destroys the restricted passage B, corresponding to the restricted passage 35 of complainants' device, quick action did not take place, because the admission of auxiliary reservoir pressure to the brake-cylinder was so rapid as to prevent the opening of check-valve 26 by the lower train-pipe pressure, in the manner which I have previously described.

With the ring 9 removed, and the restricted passage B destroyed, this valve, drawing No. 10, operated precisely as defendants'
603 valve with ring 9 removed, and without any difference. It
is not necessary, therefore, for me to detail the action of this valve, but I will refer, for a general description of its action, to the preceding part of this answer where I have described the action of defendants' valve with ring 9 removed.

This valve, drawing No. 10, is an example of integral construction of the auxiliary valve, and I will now describe its correspondence, in essential features and characteristics, with complainants' and defendants' valves.

The restricted passage B is idle, when the valve is performing

the three triple-valve functions, and is operated to restrict the flow of auxiliary reservoir pressure in the performance of the auxiliary or quick-action function, and therefore corresponds exactly, in function, with restricted passage B of defendants' valve and restricted passage 35 of complainants' valve.

Check-valve 26, of drawing No. 10, is for the purpose of preventing the return of train-pipe air to the train-pipe, after it has once passed into the brake-cylinder, for the performance of the auxiliary function. The fact that the air, in feeding and charging, passes from the main air pipe through check-valve 26, both in the device shown in drawing No. 10 and in defendants' valves, and does not do so in complainants' valve through check-valve 49, is immaterial for two reasons:

1st. The purpose of the check-valves, as shown by their location and size relative to the other parts, is to assist in the performance of the auxiliary or fourth function, by preventing the return of air pressure from the brake-cylinder to the train-pipe, as I have described.

2d. In none of these valves, as practically made, is the feed controlled by the check-valve, but is, instead, controlled by infinitely smaller fine grooves, properly located between the train-pipe and the auxiliary reservoir.

Hence, the function of check-valve 26 of drawing No. 10,
604 is the same as the function of check-valve 26 of defendants' valve, and check-valve 49 of complainants' valve.

The passage C, which it will be noticed is enormously larger than the passage s^1 of drawing No. 10, is for the purpose of admitting, in large quantity, the train-pipe pressure to the brake-cylinder, in the performance of the auxiliary or fourth function, and is located to correspond with an integral auxiliary-valve construction that I have described in a preceding answer. The passage C, therefore, corresponds in function with the passage 42 of complainants' valve, and the passage uncovered by valve 22 of defendants' valve.

The valve H, of drawing No. 10, is the type of integral auxiliary valve which I have described in a preceding answer, whose auxiliary function is the opening of a large passage to the brake-cylinder, for the admission of train-pipe pressure, and therefore corresponds with the auxiliary valve 41 of complainants' valve, and the auxiliary valve 22 of defendants' valve.

The further traverse of the piston provided in the device of drawing No. 10, has its sole purpose in opening the auxiliary passage and valve just described, and therefore corresponds to the further traverse of the piston of complainants' valve and defendants' valve, all of which further traverses actuate auxiliary valves, for the performance of the auxiliary or fourth function of quick-action triple valves.

In order that I may not be misunderstood, or at fault, by failing to describe everything which I observed in the experiments performed by me at Wilmerding, and by Mr. Boyden at Baltimore, I will now describe in detail one result obtained, which is immaterial, so far as it bears on the question in point, namely, the capability

of valve 22 of defendants' valve, for the admission of auxiliary reservoir pressure to the brake-cylinder, without, at the same time, getting quick action. But before doing this, it will be necessary to explain more in detail than has been done before, so far as
605 I can learn from the reading of the testimony in this case, the construction and operation of the device used by Mr. Boyden to determine when quick action takes place, namely, "Illustration of the glass cylinder and wood ball referred to in Mr. Boyden's answer to Q. 14" which I shall hereafter refer to as the 'ball device."

The ball has its normal position, as shown in the illustration, and can be observed through the glass case. When the air moves from the main air pipe through the glass cylinder, in sufficient quantity, it rolls the wood ball up the inclined surface of the glass cylinder, until it reaches the opposite end, where it practically stops the main passage to the brake-cylinder, and the air from the main air pipe flows through the holes provided laterally. It is clear then that these lateral holes must have a large area in total, namely, sufficient to transmit the air from the train-pipe to the brake-cylinder, during quick action. That these holes are of large size was sufficiently shown by the experiments, in which, as I have said, quick action took place perfectly, and the large volume of air required for quick action must have passed through these holes. These lateral holes are practically of the same dimensions on both ends.

It is evident then, that there is a large and substantial passage from the main air pipe to the brake-cylinder, through the lateral holes, and around the wood ball in the glass cylinder, when the large central hole is plugged by the wood ball, as shown in the illustration.

This device then is not adapted to indicate when there is a flow of small amounts of air from the train-pipe to the brake-cylinder but is adapted to show a flow of air when the flow is very great. The device does indicate a marked flow of air, when there is a quick action, in the sense in which I have described the term in a preceding answer, but it will not indicate, I think, a *small* flow of air from the main air pipe to the brake-cylinder which probably takes place under the conditions of the experiment I am about to recite
606 for the reason that there is a large open passage through the glass cylinder that is not plugged by the wood ball. I am aware that I am dealing with very fine points, but such close discriminations are warranted from the fact that the experiment I am about to recite, is one that deals with minute discriminations, so minute, in fact, that I was unable to tell whether air passed from the train-pipe to the brake-cylinder through valve 22, or not.

It will be necessary, also, to say that the gauges on the brake cylinder and the auxiliary reservoir, in the apparatus used by Mr Boyden for experimental exhibit, were not accurate, and did not coincide, and were so acknowledged by Mr. Boyden. Mr. Boyden offered to change these gauges, or correct them, but I did not deem it necessary, as I did not think the small discriminations and differ

ences incident to that experiment were material. The experiment is as follows:

One of defendants' valves, of the type shown in defendants' 1891 catalogue, was shown to be operated as a quick-action triple valve having the essential four functions. Following that, there were repeated attempts to manipulate the engineers' valve so as to admit auxiliary reservoir pressure to the brake-cylinder, through valve 22, without opening check-valve 26 and admitting air from the train-pipe to the brake-cylinder. The conditions were favorable, because there was but one brake and comparatively short piping. In about half of the experiments, full quick action took place, and air passed from the train-pipe to the brake-cylinder in sufficiently large volume to move the wooden ball. In the other half of the experiments, the following took place:

Air from the auxiliary reservoir passed through the holes in stem 18 until the pressure in the brake-cylinder was from 90 to 95 per cent. complete and full, for service application. The pressure in the brake-cylinder at that time acting under valve 22, together with the differential pressure on the opposite sides of piston 29, acted to lift valve 22 from its
607 *seat, and, at that instant, the finger of the pressure gauge on the brake-cylinder flew suddenly around a short distance, say about three pounds, to its highest indication. The amount of air admitted at this time was certainly very small, not enough to make any practical difference in braking, or to lift check-valve 26 enough, so that it could be observed, even if all the air admitted at that time had been admitted from the train-pipe. I could not determine whether check-valve 26 lifted or not, or whether any air passed from the train-pipe to the brake-cylinder, as the apparatus for showing this was not delicate enough to measure or indicate the passage of such small amounts of air.*

To sum up my answer to this question, I will say that Mr. Boyden's statement, as to an alleged "fourth valve" and "fourth function" of triple valves prior to 1887 and of complainants' and defendants' valves, is neither true or correct, as I have determined from an examination of the devices and from experiments, as set forth in this answer.

Counsel for defendants objects to all that part of the previous answer included under the "reasons" designated—*a, b, c, d, e, f, g,* and *h*, because that part of the answer contains a plain misrepresentation of Mr. Boyden's statements on page 27 (D. R.) as to complainants' "fourth valve," and as to Mr. Boyden's true reason for using illustrative "cut No. 5" in connection with his said statements.

This will be evident to the court by reference to defendants' record, page 125, and Mr. Boyden's answers 177 178 on that page. Mr. Boyden, in said answer 177, distinctly explains the object of the illustrative "cut No. 5" as follows, A. 177:

"No, I am not, as I used cut No. 5 *only* to show the course of the auxiliary reservoir air to the brake-cylinder when passing through the port 35, in my answer to Q. 9."

608 Counsel for complainants objects to the lumbering of the record with statements, in the nature of testimony, on the

part of defendants' counsel, and arguments in support of such statements, and suggests that whatever argumentative matter defendants' counsel desires to present can be submitted much more properly, and certainly quite as effectively, at the hearing of this cause.

674 Q. To what extent are such statements of your last preceding answer as relate to the appliance of patent 360,070, applicable to the statements of defendants' witness, Church, in folios 680, 681, pages 170, 171 (D. R.)?

A. They are fully applicable to the statements of Mr. Church.

Adjourned to Saturday, January 6, 1894, at 11 a. m.

NEW YORK, *January* 6, 1894—11 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of D. L. BARNES resumed:

675 Q. In folios 110, 111, p. 28 (D. R.), Mr. Boyden recites "four valves" as forming the "triple valve"—that is, the triple valve proper, in patent 360,070 and in defendants' quick-action triple valves. To what extent is such a recital a true and correct one?

A. Mr. Boyden's recital is untrue and incorrect for the following reasons, and for further reasons which I have given in preceding answers.

(*a*) Triple valves prior to 1887 and the plain triple-valve functions of patent 360,070 are but *three*, namely, the first, second and third that I have described in a preceding answer.

609 (*b*) The "main valve" which Mr. Boyden has wrongly said is port 35, is in fact the valve which performs the main functions of braking, namely, the three functions of triple valves used prior to 1887.

(*c*) The port 35 has only one function, that of admitting the air from the auxiliary reservoir to the brake-cylinder, which is the second function of triple valves used prior to 1887.

(*d*) The equivalence of port 35, in function and result, with port 31, which is the port which performs the second function of the quick-action triple valves, I have shown in my answer to Q. 673, when referring to "Complainants' Exhibit Westinghouse Modification," in which the port 35 has been entirely removed, and "the identical equivalent, in function is, in this arrangement, formed by an extension of the port opening of the port 31, which is manifestly the part which performs the second function of triple valves prior to 1887, and, in this extension, marked *x*, and by it, no new function is performed, but only the same function of passage 31, namely, that of admitting air from the auxiliary reservoir to the brake-cylinder."

(*e*) This reply of Mr. Boyden is another instance of the indefiniteness and inaccuracy of comparing compound structures, on the basis of parts to which more or less empirical names are given, instead of comparing them by their functions. As I have said before,

he number of the parts, or the names of the parts, do not necesarily indicate their equivalence in functions.

(f) The error in the parallel-column comparison given in Mr. Boyden's answer, is apparent from the fact, which I have shown in nswer to Q. 673, that the valve 22 of defendants' valve has no office n the performance of any of the three triple-valve functions of riple valves prior to 1887.

(g) If valve 22 of defendants' valve is to be denominated as the "main valve," as has been done by Mr. Boyden, then valve 41 of omplainants' valve should also be denominated a "main valve," as they both have the same function, namely, the fourth or

610 auxiliary function of quick-action triple valves. Manifestly, it is not descriptive, but is, instead, misleading, to denominate ither valve 22 of defendants' valve, or 41 of complainants' valve, s a "main valve" for the reason that those valves are not *mainly* used, but are used only for unusual conditions and for emergency. In fact such valves have been frequently referred to in the art as being "emergency" valves.

(h) A true comparison of the parts forming the three triple-valve functions prior to 1887 and those having the fourth or auxiliary function of quick-action triple valves, in complainants' and defendants' devices, is as follows:

1st. Feeding-in valve:

Valve 51, complainants' valve.

Small grooves in piston stem, defendants' valves.

2d. Valve for admission of auxiliary reservoir air to the brakecylinder:

Valves 14 and 29 and ports, complainants' valve.

Valve 18 (13) and ports, defendants' valves.

3d. Exhaust valve:

Valves 14, 33 and port, complainants' valve.

Valve 17 and port, defendants' valves.

4th. Auxiliary valve for the performance of the auxiliary or quick-action function:

Valve 41 and port, complainants' valve.

Valve 22 (15) defendants' valves.

As these valves all have corresponding functions, the comparison I have made is a manifestly correct one.

611 676 Q. What, if any, plain triple valve, or triple-valve proper, functions, are, in practice, performed, or are, in practice, required to be performed, in the device of patent 360,070, or in the defendants' quick-action triple-valve devices, by any valve or valve element, other than the first, second and third enumerated by Mr. Boyden in folios 110, p. 28 (D. R.)?

A. None whatsoever, as I have set forth in the last preceding answer.

677 Q. Is, or is not, the statement of Mr. Boyden, in the first paragraph of folio 116, p. 29 (D. R.), that one of the four valves forming the triple valve proper, in the defendants' structure, admits the main air-pipe air to the brake-cylinder, simultaneously with the

auxiliary reservoir air, when producing quick action, a true and correct statement?

A. It is quite untrue and incorrect for the following reasons:

(*a*) In defendants' valves, the valve which performs the second function of a "triple valve proper," namely, the admission of auxiliary reservoir pressure to the brake-cylinder, is valve 18, which valve is not of any value during the performance of the fourth or auxiliary function of quick-action triple valves, as I have shown by the recital of experiments made by me in a preceding answer, in which the holes of valve 18 used for the second function were suppressed by being plugged up. In that modified construction, quick action took place correctly. I have shown that valve 22 is not used in the performance of any of the functions of "a triple valve proper."

(*b*) During the performance of the quick-action function, the flow of auxiliary reservoir pressure to the brake-cylinder is through valve 22, but is controlled, in amount, by the restricted passage B, which is the equivalent of port 35 of complainants' device.

(*c*) What Mr. Boyden has termed the "fifth or auxiliary valve," but which is, in fact, simply an auxiliary valve, as I do not consider the numbering of valves of compound structures competent, *is* found in defendants' quick-action triple valves, in the form
612 of valve 22, which is used solely for, and has a capacity and location suitable for the admission of "main air-pipe air to the brake-cylinder."

For these reasons, it is clear that the auxiliary valve, for the performance of the auxiliary function, or what Mr. Boyden has incorrectly termed the "fifth" valve, is present in defendants' devices, and no valve that is used in the performance of the functions of "the triple valve proper," is used, in defendants' devices, for performing the auxiliary or quick-action function.

678 Q. Mr. Boyden states on page 30 (D. R.) that—

"This distinctly shows that the complainants' device uses two valves to perform the quick application of the brakes, one of which belongs to the *triple valve proper* while the other is an *auxiliary valve additional* to the triple-valve structure."

I understand from your preceding testimony that you have disagreed with other statements of the defendants' witnesses which appear to me to be to the same effect as that quoted, but wish you would state whether or not you find this specific statement to be a true and correct one.

A. This statement is clearly untrue and incorrect, for the reasons that I have set forth in a preceding answer, and for the further reason that the term "additional," I do not find to be warranted by any description in the specification of the patent 360,070. This statement by Mr. Boyden is still another illustration of the inaccuracy of descriptions and comparisons of compound valves, based on empirical names of parts, instead of, as they should be, on functions.

679 Q. On pages 20 and 21 (D. R.) Mr. Boyden makes the follow-

ing statement, as to the operation of defendants' quick-action triple-valve plate XI, defendants' 1891 catalogue, to wit:

"To apply the brakes fully with the auxiliary reservoir
613 pressure by the final movement of the piston, sufficient pressure is gradually exhausted from the main air pipe to move the piston its full stroke. This will unseat the main valve 22, and thereby establish full communication between the auxiliary reservoir and brake-cylinder and apply the brakes with the full auxiliary reservoir pressure.

"The operations just described are those of the 'triple valve,' *per se*, and are such as are used in the art prior to 1887."

Mr. Church makes a statement, which I understand to be substantially to the same effect, as to defendants' 1889 device, in the paragraph on page 196 (D. R.) commencing "To apply the brakes with full power in the shortest possible time," &c., and continuing in the first paragraph of folio 783, on same page, that "the operations described are generally the same as those performed by the 'triple valve proper' and do not include the special function of a quick-action triple valve."

To what extent, if at all, are the above-quoted statements of defendants' witnesses true and correct statements of fact?

A. These statements are entirely untrue and incorrect for the following reasons:

(*a*) Valve 22 cannot be unseated or operated to perform any of the functions of the "triple valve *per se*," as I have explained in a preceding answer, and no valve having the function of the auxiliary valve 22 was used in triple valves prior to 1887.

(*b*) The function, which is an auxiliary one, of valve 22, is that of opening a passage between the train-pipe and the brake-cylinder, to admit train-pipe pressure to the brake-cylinder, upon the further traverse of the piston, and valve 22 can be operated, practically, in no other way.

(*c*) Mr. Church practically denies that valve 22 is used to admit train-pipe pressure to the brake-cylinder, and yet, it is evident from the construction, that valve 22 is the *only* valve that
614 can be used in defendants' devices for that purpose. Mr. Church's practical denial is made in the following words:

"The operations described (Mr. Church is now referring to the opening of valve 22 (15) by the further traverse of the triple-valve piston) do not include the special functions of a quick-action triple valve, as that term is used to indicate the depletion of the train-pipe and the delivery of the air from the train-pipe into the brake-cylinder."

Clearly, valve 22 cannot be opened, in practical operation, without doing just what Mr. Church has said it cannot do.

680 Q. In his answer to X Q. 152, Mr. Boyden admitted that it is the fact that the functions, and the *only* functions, of the valve mechanism of patent 360,070, as recited in the specification of said patent, between line 80, p. 3, and line 51, p. 4, are:

1st. To admit air from the main air pipe to the auxiliary reservoir.

2d. To admit air from the auxiliary reservoir to the brake-cylinder, through the port controlled by the graduating valve 29.

3d. To exhaust air from the brake-cylinder to the atmosphere.

4th. To effect the admission of air directly from the main air pipe to the brake-cylinder, accompanied by a subsequent admission of auxiliary reservoir air through the port 35.

Please state whether or not you agree with Mr. Boyden, and state also whether or not the quick-action triple valve of patent 360,070 performs in practice, any function whatever, other than the four above specified?

A. I agree exactly with Mr. Boyden, as the four functions are those that I have described as being the sole and only functions of quick-action triple valves, and such valves have no other function in practical operation. I also find that Mr. Boyden has de-
615 scribed quick-action triple valves as having the same four and only functions, on page 23 (D. R.) folios 90 and 91.

681 Q. How many, and which, of the functions recited in the last preceding question were performed by triple valves, such as were known in the art prior to 1887?

A. Three, the first, second and third.

682 Q. From your familiarity with the art in air brakes for railroads, please state when first, and by whom, a triple-valve device was produced, having the capacity of performing the first, second and third functions recited in question 680, and having, in addition thereto, the capacity of effecting, when desired, the application of the brakes by the admission of air directly from the main air pipe to the brake-cylinder.

A. Such a triple-valve device was, to the best of my knowledge, first produced by George Westinghouse, Jr., and is described and shown in his patent No. 360,070.

683 Q. From your practical knowledge of, and experience with, quick-action automatic brakes, please state what are the functions, and the *only* functions, performed in practice by the defendants' quick-action triple valves shown in plate IX defendants' 1889 catalogue and plate XI defendants' 1891 catalogue.

A. The entire and only functions of these constructions are those that I have designated as the first, second, third and fourth functions of quick-action triple valves. These are as follows:

1st. The admission of air from the train-pipe to the auxiliary reservoir through the feeding-in port.

2nd. The admission of air from the auxiliary reservoir to the brake-cylinder, for the purpose of applying the brakes with auxiliary reservoir pressure, such as was common in the art prior to 1887. This is accomplished by means of the ports in valve 18, defendants' 1891 valve, and by valve 13, defendants' 1889 valve.

3rd. The exhausting of the air from the brake-cylinder to the atmosphere. This is accomplished by valve 17.

616 4th. The application of the brakes by train-pipe pressure, for the performance of the auxiliary or quick-action function. This is accomplished by the valve 22 (15) upon the further traverse of the piston.

684 Q. How many, and which, of these functions are, operatively and in results, in correspondence with the functions performed by triple valves such as were known in the art prior to 1887?

A. The first, second and third only.

685 Q. What is the function, and the *only* function, in practical operation, of the valve 22 of defendants' quick-action triple valves, plate XI defendants' 1891 catalogue, and the corresponding valve 15 of plate IX defendants' 1889 catalogue; and by what mechanical means or member are said valves actuated?

A. The function, and the only function, of valve 22 (15) of defendants' valves is to perform the auxiliary or fourth function, namely, quick action.

These valves 22 (15) are actuated solely by the piston of the triple valve upon its further traverse, which is a traverse over and above that necessary for the performance of the functions of a plain triple valve as known prior to 1887.

686 Q. In what, if any, particular, of function, means of actuation, or operative relation to the other members of the appliance which perform the first, second and third functions recited in your answer 683, does the valve 22 of defendants' 1891 quick-action triple valve, or the corresponding valve 15 of defendants' 1889 quick-action triple valve, differ from the valve 41 of the structure of patent 360,070?

A. It does not differ in any of the particulars recited.

687 Q. To what extent, if at all, is the valve 22 (15) of defendants' devices, a necessary, or a practically useful, member of said devices, for any purpose or function whatever, other than that of admitting air directly from the main air pipe to the brake-cylinder?

A. Valve 22 (15), of defendants' devices, is not at all neces-
617 sary, or practically useful, for any other purpose or function whatever than that of admitting air directly from the main air pipe to the brake-cylinder for the performance of the auxiliary function.

This non-utility of valve 22 (15) during the performance of the first three functions of triple valves prior to 1887, I find to have been admitted by Mr. Boyden in answers to X Q. 230 and X Q. 232.

The full office of valve 22 (15) of defendants' devices is the performance of quick action.

688 Q. To what extent, if at all, is a construction such as is shown in patent 220,556, in which the port or passage leading from the auxiliary reservoir to the brake-cylinder may be controlled, so as to be either partially or fully opened or uncovered, essential or desirable in the operation of a triple valve proper as known prior to 1887?

A. It is neither essential nor desirable, and, furthermore, such construction would lead to very unsatisfactory, and, in some cases, damaging, results in practice. I have shown, in a preceding answer, wherein I described experiments with a valve of this kind, that the port leading to the brake-cylinder from the auxiliary reservoir could not be opened fully except on a few of the front cars of a train.

This result would cause the front brakes to apply at once, while the rear brakes would apply later, and cause damaging shocks in the train, for reasons which I have previously set forth.

One of the most difficult results to accomplish in designing plain or quick-action triple valves, is to obtain a uniform application throughout the train as nearly as possible. This fact alone shows the undesirability of the construction described in this question.

689 Q. As a matter of fact, do, or do not, the defendants' structures possess the capacity of producing the same effect in a service application of the brakes, as is produced if the piston and valve H of patent 220,556 are allowed to make the extreme traverse which the patent shows they are capable of making?

618 A. They do not, for, as I have shown by citation of experiments, it is impossible to apply the brakes with auxiliary reservoir pressure, in a service application, in any other way than through the small ports in valve 18, defendants' valve.

I have shown, by citation of experiments, the impracticability of lifting valve 22 (15) for a service application of the brakes without, in every instance, getting, at the same time, a quick-action application.

In the device of patent 220,556, if the piston and valve H make a complete traverse, as they may be made to do on a few cars, the brakes go on forcibly, as the air from the auxiliary reservoir passes through the full port C, but, in defendants' valves, the service application of the brakes can only be made moderately, just as in the case with complainants' valve, this moderation being necessary for practical braking.

I will refer to the experiments I made, where the ring 9 of defendants' valve was removed, and the ports in the valve 18 were suppressed by being plugged up. The possibility of quick action was removed, as there was no restricted passage between the auxiliary reservoir and the brake-cylinder, and service application of the brakes could only be made through the auxiliary port controlled by the valve 22, which is normally used for quick action. With that modification, the brakes applied forcibly, and in a manner which the defendants' devices cannot be made to operate, when they are in their normal form as quick-action triple valves.

690 Q. In the construction shown by the tracing "Complainants' Exhibit Westinghouse Modification," what, if any, function is performed by the valve recess, or extended port opening x, in any operation whatever of the construction as a triple valve proper known prior to 1887, and what, if any, additional function or office is imparted to the port 31 controlled by the graduating valve, by the addition of such valve recess or extended port opening?

619 A. The valve recess or extended port opening x has no office whatever, during the performance of any of the three functions of triple valves known in the art prior to 1887.

The addition of the valve recess or extended port opening x increases the function of port 31 by causing it to act and perform the office of a restricted passage between the auxiliary reservoir and the brake-cylinder, such as is performed by port 35 of complainants'

valve, and port B of defendants' valve, to enable the auxiliary or quick-action function to be performed.

Adjourned to Monday, January 8, 1894, 10.30 a. m.

NEW YORK, *January* 8, 1894—10.30 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of D. L. BARNES resumed:

691 Q. It is stated in defendants' 1891 catalogue, page 29, referring to defendants' quick-action triple valve, plate XI, that:
"The actions of this valve in graduating, full-service application, quick action and the release, are the same as the new Westinghouse quick-action valve, thereby producing the same result in braking, which renders cars equipped with the two valves perfectly interchangeable—the hose couplings being the same."
Assuming such statement to be true, what would be the necessary and inevitable operation of the defendants' device, when used on a car or cars of a train containing other cars equipped with the quick-action triple valve of patent 360,070?

A. I understand that the statement in the question, which
620 is an extract from defendants' 1891 catalogue, refers to the present standard quick-action triple valve of the Westinghouse Air Brake Company, which is a device similar to that shown and described in the drawings and specification of patent No. 376,837, granted to George Westinghouse, Jr., January 24, 1888, but as this device is like the device described and shown in the drawing and specification of patent 360,070, in that the auxiliary valve for the performance of the auxiliary or quick-action function is actuated by the further traverse of the triple-valve piston, and as these valves operate to produce identically the same practical results in practically the same way, the statement in defendants' catalogue, quoted in the question, refers, in effect, to the practical operation of either of the devices shown in the two Westinghouse patents I have mentioned.

The necessary and inevitable operation of defendants' device, when used on a car or cars of a train containing other cars equipped with the quick-action triple valve of patent 360,070, would be the performance of the four functions of quick-action triple valves, not only in the same successive order and under the same conditions, but also coincidentally in time, and identically in *degree* of performance of the said four functions, that is:

The first function of charging must be the same in *degree*, and take place with the same increase of pressure in the train-pipe, and be performed in practically the same time, otherwise practical difficulties would arise. It has been found necessary for the committee recently appointed by the Master Car Builders' Association, to define the degree of the performance of all of the four functions of quick-action triple valves, in order to get the necessary uniformity

to make the results of both the service and emergency braking practically useful.

The service application must be performed in the same *degree*, or there will be serious shocks in the train for the reasons that I have previously set forth.

621 The release of the brakes must be performed with practically the same *degree*, or there would be a delay in releasing the brakes, or some of the brakes would be released before they should, and there would arise practical difficulties in operation.

The fourth, or auxiliary, function of quick-action triple valves, must be performed to practically the same *degree*, and in the same time, or the most disastrous results will occur in making emergency application.

Therefore, it is essential that defendants' valve, like all other practical quick-action triple valves, shall operate in conjunction with the complainants' valve, in the essential way that has been determined by the Westinghouse Air Brake Company as necessary for the practical and safe operation of quick-action brakes on trains.

It is this which has led me to a positive conviction that, as shown by the experiments I have performed, there is no difference in the degrees of performance of the second function of triple valves prior to 1887, in practical operation, between defendants' and complainants' valves.

692 Q. In his answer to R. D. Q. 238, Mr. Boyden states that in making a quick-action application of the brakes with the appliance of patent 360,070, a greater amount of air pressure would be admitted to the brake-cylinder through the port 35, than through the port 42, which is controlled by the valve 41. Do you, or not, accord with this view?

A. The relative amounts of air, and by this I mean the weights of air, (for evidently the pressure and volume vary too much to be used as a basis of comparison), that enter through the ports 35 and 42 of complainants' valve, depend upon the travel of the piston in the brake-cylinder. In average practical conditions, a greater weight of air enters through the port 42, when quick action is performed. In some cases, practically the same amount in weight enters through the two ports.

622 The substantial assistance which is obtained from the performance of the auxiliary function by complainants' valve, and by quick-action triple valves generally, in the way of a more powerful application of the brakes, and in saving air pressure, and in emptying the train-pipe, is shown by this answer, and indicates the value of the improvement in braking devised by Mr. Westinghouse and set forth in the specification of patent 360,070, and which has rendered possible the use of powerful brakes on long trains, which it was impossible to do prior to 1887.

693 Q. I understand the statements of Mr. Church, in folios 851 to 853, on page 213, and first paragraph of page 214 (D. R.), to the effect that the results produced by the valve 41 and port 42 of the appliance of patent 360,070, are produced, in defendants' devices, directly by the triple valve proper, and that Mr. Boyden has suc-

ceeded in making a triple valve proper perform the operation of quick action, without the addition of anything corresponding in name, construction, or mode of operation, with said valve 41 and port 42, to be, in substance, repeated and summarized in Mr. Church's answer 12, the errors of which you have heretofore indicated.

In order that your position, as to the above two statements of Mr. Church, may be clearly stated, I will now ask you whether or not said statements of Mr. Church are ture and correct statements?

A. They are not true and correct statements, as I have set forth in detail in answer to a preceding question.

Mr. Church has said that

"*Mr. Boyden has succeeded in making a triple valve perform the operation of admitting train-pipe air directly into the brake-cylinder* without interfering with its functions as a triple valve proper and without the addition of anything corresponding in name, construction, or mode of operation with the auxiliary valve."

I notice that Mr. Church did not say this result had been
623 secured by Mr. Boyden "without the addition of anything corresponding in" *function.* Manifestly, the "name" of a part is not necessarily descriptive of its function. The construction is, in a general way, identical in complainants' and defendants' valves, while in detail it differs materially. The "mode of operation" is absolutely identical in the two devices, as I have explained in detail heretofore, and it is not necessary for me to rehearse the reasons here. Mr. Church has said "in the complainants' patent in structure, *two valves are required* for effecting an emergency application of the brakes." The untruthfulness of this statement is shown by Mr. Boyden's experiment with the device shown in drawing No. 10, by which it was proved by Mr. Boyden that two valves are *not* required. I have before explained in detail, that the auxiliary function, namely, quick action, may be quite as well performed by an auxiliary valve, which may be a part or parcel of any other part or valve. A detailed explanation of this I have given in a preceding answer.

694 Q. To what extent do you find the comparative statements of the "valves or valve functions," in the structure of patent 360,070 and in defendants' structures respectively, made by Mr. Church on page 214 (D. R.) to be true and correct statements?

A. Mr. Church's statements are untrue and incorrect, because he has attempted to describe functions by enumerating the names of parts, which is manifestly incompetent. Whatever the number of parts or the names of the parts be, or are, whether more or less, the function of quick-action triple valves, as has been set forth in defendants' 1891 catalogue, and by Mr. Boyden in answer to X Q. 152, and in answer to Q. 9, and as set forth in a preceding answer by me, are four in number, namely, the three functions of triple valves prior to 1887 and the auxiliary, fourth, or quick-action function; there are no other functions.

695 Q. Mr. Church states, on page 215 (D. R.), that in the device of patent 360,070, "it is requisite and necessary that the aux-

624 iliary valve should be moved by the piston to uncover a port for the admission of train-pipe air to the brake-cylinder, whereas in defendants' structures, there are no auxiliary valves," etc. To what extent is this statement a true and correct one?

A. The statement in question is untrue and incorrect, except as to his statement that "it is requisite and necessary that the auxiliary valve should be moved by the piston to uncover a port for the admission of train-pipe air to the brake-cylinder." The correctness of this part of Mr. Church's statement needs no argument, as it is precisely what is described in the specification of patent 360,070.

The incorrectness of Mr. Church's statement lies in the fact, that he says that what is one of the most essential features and characteristics of defendants' valves does not exist in that valve. Clearly, from the construction, the piston opens an auxiliary valve, which admits air from the train-pipe to the brake-cylinder for the performance of the auxiliary function, upon the further traverse of that piston, and the auxiliary valve of defendants' valve has no other function than the performance of the auxiliary function, hence the error in Mr. Church's statement, which is not a statement of facts.

696 Q. From your observation of a repetition of the experiments made by Mr. Boyden, as well as from those made by yourself, state whether or not you find the opinions and conclusions expressed by Mr. Church in his answer 13, commencing with folio 914, p. 229, (D. R.) as to the Boyden experiments, to be warranted or well founded?

A. They are neither warranted nor well founded, either upon logical reasoning or upon facts developed by the experiments.

I have shown, in a preceding answer, that the "principle of momentary differential pressures" is as old as triple valves in the art, and that it is not new, and was not invented by Mr. Boyden, so far as the records of the art are competent to show this. All
625 triple valves, whether plain or quick-action, depend upon "the principle of momentary differential pressures" and "restricted passages" for their operation.

697 Q. Referring to the drawings, "Complainants' Exhibit Illustrations," please explain what the same represent, so far as you may consider such an explanation to be necessary or desirable to facilitate an understanding of the drawings by the court?

A. Drawings No. 1 to 22 inclusive, are marked with titles which indicate the meanings of the drawings, and probably no further explanation is necessary.

The remaining drawings will explain more clearly some parts of my testimony, and therefore a further description may be useful.

Drawing No. 23 illustrates the "triple valve proper" part of defendants' 1891 valve. In this device, in which the valve 22 has been suppressed, so as not to be operative, the first function of charging, and the third function of release, are performed when the parts are in the position shown in drawing No. 23, while the second function of admitting auxiliary reservoir pressure to the brake-

cylinder is performed when the parts are in the position shown in drawing No. 24, in which, as well as in drawing No. 23, the auxiliary valve 22, for the performance of the auxiliary function, has been suppressed. As I have shown by experiment, cited in a preceding answer, all the functions of a "triple valve proper" are satisfactorily and completely performed by the device as shown in drawings No. 23 and No. 24, without the auxiliary valve 22, which shows that the auxiliary valve 22 has no useful purpose in the performance of any of the three functions of a "triple valve proper." It also is shown that the further traverse of the piston, which is suppressed in drawings 23 and 24, has no useful purpose in the performance of the three functions of a "triple valve proper."

Drawings No. 25 and No. 26 show the equivalence of the auxiliary valve 22 of defendants' valve and the auxiliary valve
626 41 of complainants' valve. Valve 22, in this construction, is operated in the same way, and has the same location with respect to other parts, so far as practical operation is concerned, as in defendants' valve. This construction has the parts belonging to the "triple valve proper" function of complainants' valve. In this construction, port 35, the restricted passage, has been removed, as port B is its identical equivalent, as I have before explained, and this serves to illustrate that explanation.

Valve 22, identical with valve 22 of defendants' valve, is actuated by the further traverse of the piston to perform the auxiliary function, just as in defendants' valves. In this construction, it is evident that none of the three functions of a "triple valve proper," are performed by the valve 22, any more than in complainants' valve they are performed by valve 41. This drawing serves to illustrate the fact that no function is performed, by complainants' valve, that is not also performed, in the same way, by defendants' valve.

Drawing No. 26 differs from drawing No. 25, in that the restricted passage B, corresponding to the restricted passage 35 of complainants' valve, is differently located, and forms, together with the passage uncovered by the valve 22, upon the further traverse of the triple-valve piston, the essential differential passages characteristic of all quick-action triple valves, which are exemplified by the differential passages 35 and 42 of complainants' valve.

Drawing No. 27 illustrates, even more forcibly, the equivalence of passage B of defendants' valves and restricted passage 35 of complainants' valve, as this construction, drawing No. 27, differs from the construction of drawing No. 26, only by the suppression of the restricted passage B, drawing No. 26, and the insertion of the restricted passage 35 of complainants' valve. It is evident from these drawings, that restricted passage 35 of complainants' valve, and restricted passage B of defendants' valves, have identically the same function, which is to form, together with the larger and more
627 capacious passage leading from the train-pipe to the brake-cylinder, the "differential passages" essential for the practical operation of quick-action triple valves.

698 Q. Will you please produce and explain a drawing illustrating the application of quick-action brake apparatus to freight cars,

and the relation of the apparatus of one car to that of others of the train?

A. The three cars shown on the lower part of the drawing, which I produce, illustrate in detail the location of the apparatus on individual and succeeding cars of a train, and show how the devices work in series. Each car is provided with a train pipe from end to end, with the necessary stop-valves, hose, and couplings. Near the centre of the car is located the brake-cylinder and auxiliary reservoir, which are placed tandem. On the end of the auxiliary reservoir, there is located a quick-action triple valve, which is connected to the train-pipe by a branch pipe, as shown. A strainer is provided at the joint between the branch pipe and the train-pipe, to prevent grit and dirt reaching the quick-action triple valve.

In operation, during the performance of the auxiliary or fourth function, namely, quick action, the air taken from the train-pipe and admitted to the brake-cylinder, reduces the pressure in the train-pipe, and, by this reduction, the next succeeding brake is applied with quick action, thus further reducing the pressure and again applying the next succeeding brake, and so on throughout the train. This action proceeds through a long train with practically the rapidity of the velocity of sound, a velocity of application wholly unknown prior to 1887. The time occupied in applying all the brakes in a train of fifty cars, which is about three-eighths of a mile long, is less than two seconds from the front to the rear car.

At the top of the drawing which I produce, is shown a train of fifty cars, with a caboose at the rear and a locomotive in front. A train of this kind has the following dimensions:

Total weight about 2,000,000 pounds.
628 Total length about 1,900 feet.
Total length of each car, about 38 feet and 4 inches.
Capacity of each car for freight, 60,000 pounds.
Capacity of total train for freight, 3,000,000 pounds or 1,500 tons.
Total weight of loaded train, 5,000,000 pounds or 2,500 tons.

Prior to 1887, it was not safe or practical to run a train of this kind, or even a much shorter one, with the air brakes then in use, owing to the severe shocks produced in the train. It was not possible to use the plain triple valve, known prior to 1887, with a high degree of performance of the second function, that is, by opening a large passage from the auxiliary reservoir to the brake-cylinder, for the reason, that the brakes on the front of the train apply so much quicker than those on the rear, that the front of the train would be slowed down, and the rear would run into it and produce serious damage, not only to the freight, but to the train itself. It was the object of Mr. Westinghouse, in devising the quick-action triple valve described in the specification and drawings of patent 360,070, to decrease the time required to apply the brakes, so as to bring the brakes on the rear into action almost simultaneously with those on the front of the train. In 1887, it was pronounced by the committee of the Master Car Builders' Association, that a sufficiently quick-acting brake for a fifty-car train could not be wholly actuated by air, as up to that time no wholly air brake had been produced that

could be practically used for making quick stops with safety on long trains. Mr. Westinghouse equipped a train of fifty cars with a quick-action brake, in which the fourth, or auxiliary, function of admitting air from the train-pipe to the brake-cylinder was performed, and made numerous experiments, many of which I witnessed. Two of the most useful results that were shown by these experiments were the following:

With the plain brake, on twelve passenger cars equipped
629 as prior to 1887, at a speed of 40 miles an hour, it required
862 feet to make a stop, while with 20 freight cars, equipped with quick-action triple valves, a stop was made in 459 feet. These results are the average of many experiments.

With a fifty-car train, such as shown on the drawing, running at 20 miles an hour, it required 1,800 feet to make a stop with hand brakes, while, with the same cars, using the quick-action triple valves, a stop was made in 100 feet. The great increase in safety that resulted from the use of quick-action triple valves, is apparent, as it was found impossible to use a plain triple valve with a forcible action on long trains.

Another important result from these experiments, was the illustration of the fact, that with quick-action triple valves, a train can be broken in two parts without danger of the parts coming together and causing a wreck.

Counsel for complainants offers in evidence the drawing referred to by witness, and the same is marked "Complainants' Exhibit Drawing Quick-action Automatic Freight Brake."

699 Q. Referring you to the Westinghouse patent No. 217,838, to what extent, if at all, do you find the device therein set forth to be adapted to practical railroad service in an automatic air-brake system?

A. It is not at all applicable, for the plain reason that it could not be used practically. Such a device so obstructs the feeding or charging process as to prevent its practical application to practical trains.

It would be impossible to graduate the brakes in a service application, so as to make the necessary difference in the force of applying the brakes.

The reasons for the inefficiency of this device in release, in charging, and in service application, are as follows:

In order to charge the brakes, the valve E must be lifted against
the spring *e*. This resistance is greater than can be allowed
630 in service, and would result in the charging of only a few
brakes at the front of the train.

In the application of the brakes, the piston D would move down, until a passage was opened from the train-pipe on one side, past the point *s*, and through the port C, which would result in the train-pipe being wholly emptied, and would entirely destroy the brakes for service application and graduation.

In releasing the brakes, the air coming from the main reservoir on the engine has but little velocity and impulse, not enough prac-

tically to push the piston D back to close the passage past the point *s*, and, therefore, the charging air would go out through the port C and the brakes would not be charged. Again, if, in some cases, the piston D did return to the position shown in figure 1 of the patent in question, then the releasing pressure would have to operate against the spring *e*, and it would be impossible to release the brakes, on any but the first few cars, with a rapidity sufficient for practical operation.

700 Q. In the specification of patent 360,070 (lines 94 to 99, page 4,) I find a reference made to

"a construction in which 'an always-open one-way passage' from the main air pipe to the brake-cylinder is uncovered by the piston of the triple valve simultaneously with the opening of the passage from the auxiliary reservoir to the brake-cylinder"

as being a construction which had been proposed prior to patent 360,070.

As you understand the construction referred to in the extract from the specification above quoted, do you or not, find a similar or equivalent construction in either of the defendants' quick-action triple valves in this suit?

A. I do not find any construction in either of the defendants' quick-action triple valves which answers to the description quoted in the question.

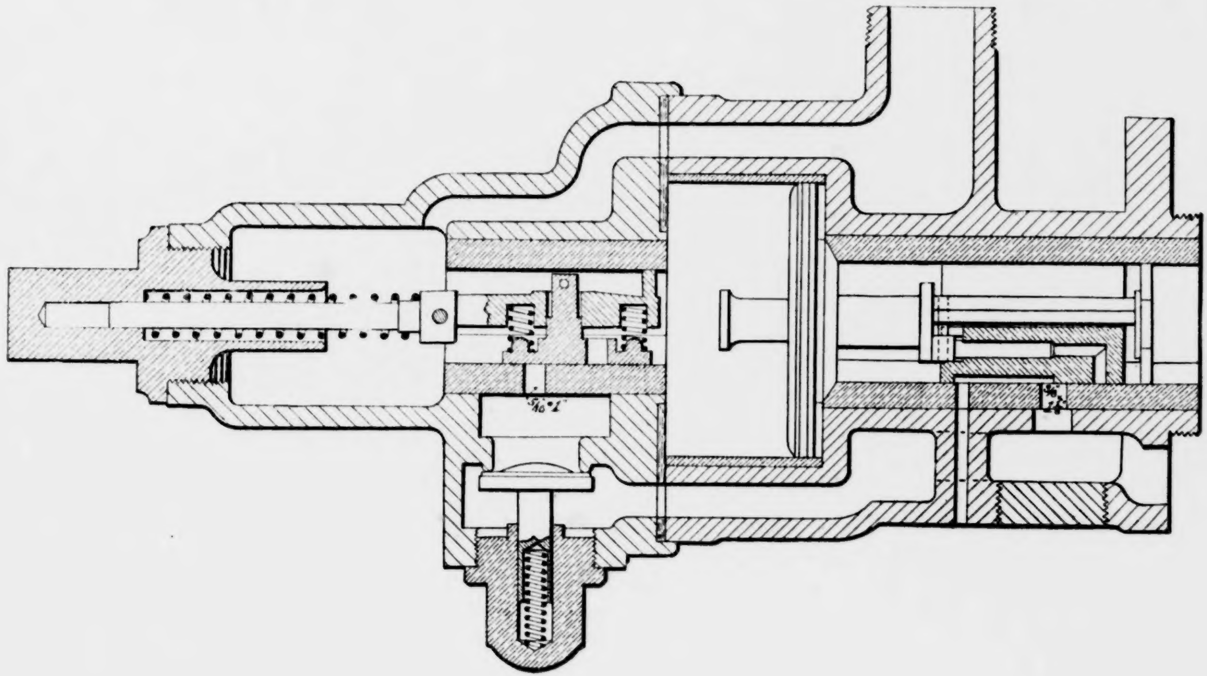
631 701 Q. I understand the defendants' witnesses to allege and claim that defendants' structures operate on a "new principle," by the employment of "differential passages," and I also understand from your testimony that the appliance of patent 360,070 employs differential passages of corresponding functions. What would be the effect of doing away with the differential relation of said passages in the appliance of said patent 360,070?

A. I have explained in a preceding answer, and described experiments which add to that explanation, how the removal of differential passages resulted in destroying the auxiliary or quick-action function of quick-action triple valves.

The removal of the ring 9 of defendants' 1891 valve destroys the differential passage B, just as the removal of the ring 9 destroyed the differential passage B of the combined Westinghouse and Boyden valve shown in drawing No. 10, defendants' "illustrative cuts," and just as the enlargement of the port 35, or its equivalent, would destroy the quick-action function of the device of patent 360,070.

I produce a drawing showing a modification of complainants' valve, in which there is no restricted passage between the auxiliary reservoir and the brake-cylinder upon the further traverse of the piston; therefore the quick action is destroyed, because the pressure from the auxiliary reservoir reaches the back side of the check-valve, and prevents its opening by the lower train-pipe pressure, as I have described in detail in a preceding answer. I have added two dotted lines to the blue print, to show that the passage leading to the brake-cylinder is connected with the passage in which the check-valve is located.

Complainants' Exhibit "Westinghouse Device without Differential Passages."



The blue print produced by the witness is offered in evidence by counsel for complainants and is marked "Complainants' Exhibit Modification Westinghouse Device without Differential Passages."

(Here follows diagram marked p 630*a*.)

632 702 Q. You have, in your previous testimony, referred to an "integral" construction of the main and auxiliary valves of a quick-action triple valve. In what, if any, essential or characteristic features of practical operation, would, or does, such integral construction differ from the appliance described in patent 360,070?

A. It does not differ in any essential feature or characteristic; but performs the same four functions of quick-action triple valves, and produces the same practical result. This I have shown in my answer describing the experiments with the device shown in drawing No. 10, defendants' "illustrative cuts," which is an example of the integral construction of the main and auxiliary valves of quick-action triple valves.

In the integral construction, the further traverse of the triple-valve piston opens an auxiliary valve to admit air from the train-pipe to the brake-cylinder, for the performance of the auxiliary or fourth function, exactly and precisely as is done in the device described and shown in the drawings and specification of patent 360,070.

703 Q. In what, if any, essential or characteristic feature of practical operation, would, or does, such an integral construction differ from the defendants' quick-action triple valves of plate IX defendants' 1889 catalogue and plate XI defendants' 1891 catalogue?

A. It does not differ in any essential feature or characteristic, or in function, nor would it produce any different result, in practical operation, from those which are produced by defendants' 1889 and 1891 valves.

This is fully shown by my recital of the experiments made with the device shown in drawing No. 10, defendants' "illustrative cuts," which illustrates an integral construction, and which operates identically with the operation of defendants' 1889 and 1891 valves. In both, and all, of these valves, the further traverse of the
633 triple-valve piston actuates an auxiliary valve, which admits air from the train-pipe to the brake-cylinder to perform the fourth or auxiliary function.

704 Q. I understand the defendants' witnesses to allege and claim, in substance, that the defendants' structures are simply plain triple valves, as used prior to 1887, and having the general characteristics of the device of patent 220,556, but with the addition of differential passages.

Please state whether or not such allegation and claim is well founded or warranted, and, in your answer, make such a comparison of the structure of patent 220,556 with the defendants' structure, as may be necessary to make your meaning clear.

A. I do not consider that such claim is warranted or well founded, for the following reasons:

First. The valve shown and described in the specification of patent 220,556 has but three functions, while complainants' valves have four functions.

Second. The device of patent 220,556 has a wide variation of performance of the second function of plain triple valves, while defendants' valves have not, as I have shown by experiment.

Third. The device shown in patent No. 220,556 has no passage directly from the train-pipe to the brake-cylinder, while defendants' valves have such passages.

Fourth. The device shown in patent 220,556 has no auxiliary valve which controls the passage leading from the train-pipe to the brake-cylinder, while defendants' valves have such passage.

Fifth. Device shown in patent 220,556 has no further traverse of the piston which opens an auxiliary valve which controls the passage leading from the train-pipe to the brake-cylinder, while defendants' valves have such a further traverse which performs the said office.

Sixth. The device shown in patent 220,556 has no check-valve for the purpose of retaining train-pipe pressure in the brake-cylinder when that pressure has once entered the brake cylinder, while defendants' valves have such check-valve for said purpose.

634 Seventh. The device shown in patent 220,556 has no restricted passage between the auxiliary reservoir and the brake-cylinder, to withhold the auxiliary reservoir pressure, so it cannot enter and suffocate the check-valve and prevent its opening by the lower train-pipe pressure, while the defendants' valves have a restricted passage for said purpose.

Eighth. The device shown in patent 220,556 has no differential passages, such as are essential to all quick-action triple valves to enable the train-pipe pressure to enter in a large amount before the pressure enters the brake-cylinder from the auxiliary reservoir, so that the train-pipe may be emptied and quick action produced, while defendants' valves have such differential passages.

705 Q. In the specification of the Boyden patent, No. 481,134, which patent Mr. Boyden admits, sets forth a quick-action triple valve, similar in all essentials, to that of plate IX defendants' 1889 catalogue, I find (lines 86 to 95, page 5) the following statement:

"It will be seen that my present invention for introducing train-pipe air into the brake-cylinder for emergency stops differs essentially from the device shown in the said patent No. 360,070, because I have provided a new principle of construction and a new mode of operation, by use of which the desired result aforesaid may be produced without the aid of the auxiliary valve heretofore required for the purpose."

In the specification of the Boyden patent No. 481,135, which patent Mr. Boyden admits, sets forth a quick-action triple valve, similar, in all essentials, to that of plate XI defendants' 1891 catalogue, I find (lines 73 to 79, p. 1) the following statement:

"It will be seen that the means I have thus provided for
635 introducing train-pipe air into the brake-cylinder for emer-

gency stops differs, essentially, from that shown in said patent No. 360,070, and that said means involve a new mode of operation."

To what extent, if at all, are the above statements true or correct statements of fact?

A. The statements quoted in the question are not true or correct, for reasons that I have set forth at length in my testimony, when referring to defendants' valves corresponding with those of the respective patents mentioned, and it is not necessary for me to describe the errors in the statements again.

706 Q. In the specification of the Boyden patent No. 481,134 I find that the valve F, shown in the drawings, is termed throughout the "main" valve.

Please state whether or not such designation of the valve F of this patent is a correct one?

A. It is not a correct designation of valve F, for the reasons that I have given in answers to several preceding questions relating to valve 15 of the device of plate IX defendants' 1889 catalogue. The valve F, shown in the drawing of the patent, is the same as valve 15 of this plate.

As I have before explained, in speaking of the valve 15, the valve F performs none of the main functions of braking, and is used only to perform the auxiliary, fourth, or quick-action function.

707 Q. In the specification of the Boyden patent No. 481,135 I find that the valve 22, shown in the drawings, is termed the "main" valve.

Please state whether or not such designation of the valve 22 of this patent is a correct one?

A. It is not a true and correct designation of valve 22, as I have shown in replies to several preceding questions, wherein I referred to the valve 22 of plate XI defendants' 1891 catalogue. The valve 22 of patent No. 481,135 is the same as the valve 22 of this plate.

As I have before explained in speaking of valve 22, that
636 valve performs none of the main functions of braking and is used only to perform the auxiliary, fourth, or quick-action function.

708 Q. In a portion of the specification of the Boyden patent No. 481,135 which purports to describe the "operation" of the appliance of said patent, I find that it is stated that "the brakes may be applied fully in two ways: first, by the auxiliary reservoir pressure alone, and, second, by the auxiliary reservoir pressure in conjunction with the train-pipe pressure" (lines 79 to 84, p. 3).

The specification also says "to apply the brakes fully for an ordinary stop, a limited amount of train-pipe air is continuously discharged from the engineers' valve" etc., and goes on to describe the alleged operation which thereupon takes place (lines 88 to 121, p. 3).

To what extent, if at all, are the statements above referred to, as to the alleged operation of the appliance of patent 481,135, true and correct in fact?

A. The statement is not correct in fact, as I have shown in reply to a preceding question, when describing experiments made with

the device shown in plate XI of defendants' 1891 catalogue, in which device valve 22 is the same as the valve 22 of the device shown and described in patent 481,135.

I have shown that the valve 22 cannot be lifted or opened, for the application of the brakes with auxiliary reservoir pressure, without at the same time producing quick action. In fact, valve 22 of these devices has no other office or function than the performance of the auxiliary, quick-action, or fourth function, of quick-action triple valves, and this I have so fully set forth that it is not necessary to do it again.

Adjourned to Tuesday, January 9, 1894, at 10 a. m.

637 NEW YORK, *January* 9, 1894—10 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of D. L. BARNES resumed:

Counsel for defendants states that, as will appear from the record, this witness has been examined as "a practical expert in the art of automatic brakes for railroads," and as "a mechanical engineer familiar with air-brake practice." The witness has shown himself to have no experience in connection with questions relating to letters patent for inventions, and to have no qualifications which make him competent for explaining the scope of letters patent.

Counsel for defendants, therefore, objects to each and all of the several statements and arguments made by this witness, where, as a person experienced in questions relating to letters patent, he has expounded or attempted to expound, the scope of the specification of complainants' patent in suit, No. 360,070, in disregard of, and without reference to, the limitations and restrictions of said patent. The objectionable statements now referred to are found in answers to questions 667, 672, 673, 675 and others, and this part of the testimony is objected to because the witness is not competent to give such testimony.

Counsel for defendants does not, of course, object to that part of the testimony of the witness, where, as a mechanical expert, he has explained the constructions shown in complainants' said patent 360,070 and the mode of operation of such constructions.

Counsel for complainants again asks the attention of the court to the fact that this witness has not been asked to explain, and
638 has not assumed to explain, "the scope of letters patent," and also to the apparent inability of defendants' counsel to understand that the specifications of letters patent, like any other specifications of mechanism, are technical descriptions, addressed to practical men familiar with the arts to which they relate, and that the testimony of such practical experts, in relation to the construction and mode of operation, or principle of operation, of the mechanisms to which such technical descriptions relate, is competent in the fullest sense. It is, therefore, submitted that the objections of

defendants' counsel, if they mean anything, are directed, not to what the witness has said, but to what the witness has sedulously avoided saying.

Cross-examination *de bene esse* by CHARLES B. MANN, Esq., of counsel for defendants, reserving exceptions taken:

709 X Q. Please state when, where, and by whom you were duly sworn as a witness to testify in this cause?

A. On the evening of Wednesday, December 13th, 1893, in the city of Allegheny, Pennsylvania, by Mr. F. E. Gaither, the examiner in this case.

710 X Q. You have referred to Mr. Boyden's statement in folio 75, p. 19, (D. R.) and have drawn a distinction, or attempted to draw one, between the meaning of the word "*additional*" and the word "*auxiliary*," as Mr. Boyden used them when describing the *essential features* of complainants' device of patent 360,070. I now ask you what warrant you have for making any distinction as to the meaning of these words used by Mr. Boyden?

Objected to as already answered; the witness having given, in his deposition-in-chief, his reasons and warrant for making the statements which he did make.

639 A. I was asked, Q. 667, to what extent I agreed with Mr. Boyden's statement in folio 75, p. 19, (D. R.) as to the essential features of the quick-action triple valve shown and described in the specification and drawings of patent 360,070, and I was compelled to call attention to the unwarranted use of the term "additional," in order that my answer might be a true and correct one.

I understood that I was in the position of one skilled in the art of braking, and was asked to explain what is absolutely essential in a quick-action triple valve, in order that it may correspond to the specification of patent 360,070, and this I did by explaining that it was essential that there should be an auxiliary valve, actuated by the further traverse of the piston, for the performance of the auxiliary or fourth function, as is distinctly set forth in several places in the specification. The auxiliary valve may be, as the term "auxiliary" implies, a part or parcel of any other part of the mechanism, but its function must be auxiliary, and it must be actuated by the further traverse of the piston. Manifestly, the number of constructions to fulfill the specification of the patent is very great, and the drawings of the patent show one of these constructions. I am accustomed to building mechanisms from specifications, and the foregoing is my warrant for making the reply that I did.

711 X Q. You say that you were compelled to call attention to the unwarranted use of the term "additional." Why do you state that the use of this word is unwarranted?

Same objection.

A. Because it does not state the fact, with reference to the specification of patent 360,070, and implies a meaning that is not an es-

sential or characteristic feature of the specification of patent 360,070. As I have said before, it is only essential that the part in question shall be "auxiliary," which is a term referring to the function, and not to the integrality.

640 712 X Q. My question 711 did not ask what was the essential or characteristic features of the specification of patent 360,070, but why you stated that the use of the word "additional" was unwarranted. Please to answer this question?

Objected to as fully answered in reply to X Q. 681, in which the witness stated specifically why he was compelled to call attention to the unwarranted use of the term "additional."

A. It is unwarranted because it does not state the fact with reference to the specification of patent 360,070, and further, it is unwarranted because it implies a meaning that is not an essential or characteristic meaning or feature of that specification, as I have several times before explained in detail.

713 X Q. In your answer to Q. 667, you made this statement: "I cannot find the term 'additional' used in the specification and description of patent 360,070."

I will now quote from the specification of that patent, p. 3, line 39, as follows:

"So far as hereinbefore described, the triple valve accords in all substantial particulars with, and is adapted to operate similarly to, those of my letters patent Nos. 168,359, 172,064 and 220,556, and in order that it may perform the further functions requisite in the practice of my present invention, it is provided with certain additional members, which will now be described."

As it is plain from the matter just quoted that the term "*additional*" is used in the specification of patent 360,070, although you failed to find it, I now ask you if you will not admit that you were mistaken?

A. No, for in the question the quotation reads "certain additional members" in which the term additional is distinctly ex-
641 plained and modified by the term members. I now quote from the Century Dictionary on this point:

"An integral part of an animal body having a distinct function."

"A part of an aggregate or whole."

I did not consider that the term "additional," as there used, meant "separated," and I now see, by reference, that I was right, and this is the explanation which, added to my answer to Q. 667, would have made it perhaps more intelligent, but as the answer was a long one, I was led to contractions. This is the reason why I have answered "no," to this question. Manifestly, no device differing so much in function as the devices shown and described in patents Nos. 220,556 and 360,070 can be made without "additional" members, the one over and above the other, but as I have explained, and as the terms distinctly and clearly specify, the parts need not be separated, but may be or may not be a part of the same integral or whole of any part.

714 X Q. Then you say that, although the word "additional" is

BLEED THR

used in the specification of complainants' patent, and in your answer to Q. 667 you said, without any reservation whatever:

"I cannot find the term 'additional' used in the specification and description of patent 360,070,"

yet, notwithstanding this discrepancy, you say that you were not mistaken. Is this so?

A. I was certainly not mistaken as to the unwarranted use of the term "additional," as implying separation, and I have explained, in my answer to X Q. 713, how my answer to Q. 667, in the part which you have quoted, is to be understood.

Answer objected to as not responsive to the question.

642 715 X Q. You made the statement, that the term "additional" could not be found in the specification of patent 360,070. I have pointed out that term as being in line 46, page 3, of the specification, and I asked you if, in making the statement that you did, that you could not find it, you were not mistaken, or had not overlooked it, and your answer to that question was "no." Now I ask you how you reconcile that answer with the facts?

Objected to as misstating the witness' testimony, he not having answered merely "no," as is directly implied in the question, but having, as a matter of fact, commenced his answer with the word "no," and continued by giving his reasons.

A. My answer taken as a whole, is in perfect accordance with the facts. I have frankly confessed in answer to X Q. 713, that my answer to Q. 667 would be more explicit, if to it had been added the explanation given in answer to X Q. 713, as in answering Q. 667 I was referring to the use of the term "additional" in the sense of being "separated," and, as I have explained, it is not there used in that sense, but in distinctly another sense, as it is specifically explained by the term "members," and this is the way in which I wish my answers to be reconciled with the fact.

716 X Q. You say "I have frankly confessed" that my answer would be more explicit, if to it had been added the explanation made in answer 713. What I want to ask you now, is whether you will not frankly confess that in making the statement unqualifiedly, that you could not find the term "additional" in patent 360,070, you were mistaken, or had overlooked the fact, that the word was there?

A. I will now quote what I said in answer to Q. 667, and will then show that I was not mistaken, and therefore have no confession of mistake to make, and again add, that my answer to
643 Q. 667 would be more explicit, if it was explained as I have done in answer to X Q. 713; but I do not yet see how there need be any mistake or misunderstanding of my answer, because, in the same sentence, with the part of my answer which has been quoted in X Q. 713, I explained right there, with the statement quoted, the "sense" in which I was referring to the term "additional." I now quote what I said on this point:

"In conclusion then, as to the use of the term 'additional' by Mr. Boyden, *in the sense of being separated in structure,* the term is indefinite and I do not find it mentioned in the description of the device shown in patent 360,070, and it is not necesssry for the full performance of all of the four functions of the quick-action triple valve shown in that patent, that there be any additional valve, in the sense of being separated as to structure."

I do not see how this can be misunderstood, as the "sense" in which I was using the term "additional" was fully explained. The error that is apparently in the mind of the counsel is, that my full answer has not been read as an entirety, but, instead, the specific statement, without the explanatory parts in the same sentence, has been selected. With the explanatory part, and with my further explanation in answer to X Q. 713, my meaning is complete, and it is clear that I was not mistaken.

717 X Q. I do not think that there is any error in my mind about this matter. You distinctly stated at the outset of your answer 667 "I cannot find the term additional used in the specification and description of patent 360,070. I quote from the specification of patent 360,070, p. 4, line 20." Now I ask you to point out to me any qualification whatever, with respect to your statement just quoted.

A. The qualification will be found in my answer to Q. 667, following immediately upon the quotation just given in this
644 question, which shows clearly that I was referring to the term "additional" in the sense of being "separated." The explanation reads, "the term 'additional' as used by Mr. Boyden carries with it a sense of separation." I have already explained wherein my answer to Q. 667, which is a long answer, could be more explicit, if added to and further explained, as I have done in answer to X Q. 713, and the quotation from my answer to Q. 667, as given in this question I am now answering, would be more explicit, and would convey exactly what I mean, if modified by the statement in my answer to X Q. 713, and this is the qualification with respect to the statement quoted in this question which I now point out, as requested.

718 X Q. It is true that you made a statement in answer 667, as to a particular sense in which you imagined or supposed that Mr. Boyden may have used the word "additional," and your arguments, in that answer, relate to this particular understanding that you seem to have had, as to the "sense" in which Mr. Boyden used the word. But I ask you now to point out, in your answer 667, if you can, where you stated that you could not find the term "additional" used in the specification of patent 360,070, in the particular "sense of separation;" and to point out, if you can, where, in that answer 667, you admit that the term "additional" is used in the specification of patent 360,070.

A. The question is in fact two questions. I will answer the first before the second.

In that part of the answer to Q. 667, commencing with the words "I cannot find the term 'additional,'" and ending with the words "mechanism which performs the fourth function, namely, quick

action," and in the part commencing with the words "in conclusion then, as to the use of the term 'additional,'" continuing on to the words "upon the further traverse of the triple-valve piston," and in the general nature and text of the answer, will be found very clearly expressed, when taken all together, as it should be,
645 my statement that the term "additional" was not used in the specification of patent 360,070 in the particular sense of "separation." A specific case is found in the following quotation from that answer:

"I cannot find that the inventor, in the description and specification of the device of patent 360,070, conveyed, or intended to convey, the sense of integrality or non-integrality, when referring to, and describing, the auxiliary mechanism which performs the fourth function, namely, quick action."

In answer to the second question of the double question I am now answering, I will say that it must be clear that, although the answer to Q. 667 is a long one and covers a good deal of ground, yet there are manifestly many things that are not said, and many statements that are not made, and if there is anything that I have omitted, that the counsel wishes to have me admit or state, I will try to do so, if it accords with the facts. I cannot consent to admit that my answer is wrong when fully considered, and this must be clear from the explanation I made in answer to X Q. 713.

Answer objected to as not responsive to the question.

719 X Q. Your answer 667 is a statement and argument dealing very largely with your views as to the difference between the meaning of the words "additional," "auxiliary," "supplemental" and "separated," and as your argument appears to hang upon the peg that Mr. Boyden used the word "additional" in the sense of "separated," and, in this connection, you made the statement, which I have pointed out several times, to wit, that you could not find the term "additional" in the specification of patent 360,070. I ask you now whether, in view of the explanation that you have given
646 with reference to your inability to find that term in the specification, it would not have been more candid, and have been the whole truth, to have stated, in that connection, that the word "additional" *was* in the specification.

Objected to as cumbering the record, and wasting complainants' time, with useless and improper statements and arguments of defendants' counsel, as to what the witness has said and what he has not said, and what he ought to have said and what he ought not to have said, which are in nowise calculated to enlighten the court upon any questions in this cause. Complainants' counsel submits to the court that, as he now requests defendants' counsel to do, the latter should limit his questions to inquiries as to such matters that he desires to be informed upon, and should refrain from arguments, which may be perfectly proper at the hearing, but which can have no result here beyond that of wasting time.

Counsel for defendants replies that he cannot reasonably be ex-

to in line 46, p. 3, of the specification of the patent 360,070. I have sought to elicit a categorical answer to that question, but thus far you have, in your answers, wandered from the point. I now ask you if you will give me a categorical answer, yes or no?

650 A. Yes, I have just said in the preceding answer that any sort of an "auxiliary slide-valve," whether integral or non-integral, is an "additional member," and is one of the "certain additional members" described in the specification of patent 360,070.

727 X Q. In your examination-in-chief you testified that you *had been led to infer* that Mr. Boyden, when referring to the "triple valve proper" and the "auxiliary valve" of complainants' patent 360,070 as the two valves which perform the quick application of the brakes, used the term "additional" in connection with the auxiliary valve, in the *sense of being separated* from the triple valve. You dissented from this view.

Now I ask you, did not Mr. Boyden have good ground for using the term "additional" in the sense of "separate," in view of the fact that complainants' patent, in the drawings, shows the "auxiliary valve 41" to be entirely separate from the triple valve, and the specification describes it in terms that make it perfectly clear that in its structure it is separate from the triple valve.

Counsel for complainants objects to, protests against, and ask- the attention of the court to the waste of time caused by defendants' counsel persistently inserting, in his questions, lengthy arguments in support of his views of the case, instead of limiting his questions, as he should do, to the matters as to which he desires to obtain either statements of mechanical fact or expert opinions from the witness.

Counsel for defendants replies that this witness has, at great length, given his views and opinions as to what Mr. Boyden probably meant, or what he thinks he meant, in using the word "additional" in his testimony, and he has gone to the length of expressing opinions as to what the specification of the patent means, and what it does not mean, in endeavoring to controvert
651 and deny views which he supposes Mr. Boyden to hold.

As the question now put to the witness is distinctly based upon facts that are pointed out in complainants' patent, it would seem to be entirely proper that the witness' arguments and opinions should be tested by the question now addressed to him.

Counsel for complainants rejoins that the facts just stated by defendants' counsel as to the testimony of this witness, if they be facts, constitute no warrant for the constant interjection of argumentative matter into the questions of defendants' counsel.

A. No.

728 X Q. Will you please indicate, if you can, any portion of the drawing which shows, or the specification of complainants' patent which states, either directly or in substance, that the "auxiliary valve" 41 which performs the function of admitting compressed air directly from the main air pipe to the brake-cylinder, may be integral with the triple valve, or the main valve of the triple valve?

A. Line 51, page 3, of specification, and line 24, p. 4, of specification. As a specification of a construction, I should distinctly understand from this that the essential feature and characteristic of the slide-valve 41 is, that it shall be "auxiliary," and as that term does not refer to anything but the function of the slide-valve, and not at all to its integrality, I should certainly understand that the specification meant that the slide valve 41 might be integral or non-integral so long as its function was an "auxiliary" one.

Answer objected to as irresponsive to the question.

729 X Q. The witness' attention is called to the last ques-
652 tion, in which he was distinctly asked to point out where the
specification states that the auxiliary valve 41 may be integral with the triple valve. A responsive answer is requested to that question.

Objected to as fully answered, the witness having in reply to X Q. 728, specified lines 51, p. 3, and 24, p. 4, and stated his distinct understanding of such matter in "a specification of a construction."

Counsel for defendants replies that it is submitted to the court that the answer of the witness is not responsive to the question propounded to him, and, if he can indicate in the specification of the patent any place where it is stated that the auxiliary valve may be *integral* with the triple valve, his so doing will be a satisfactory response.

Counsel for complainants invites the attention of the court to the fact that defendants' counsel has now changed the terms of the question as to which he requests a "responsive answer." In X Q. 728 he asks for a reference to a portion of the specification which states "either directly or in substance," and his present inquiry, as supplemented by his reply to complainants' counsel's objection, asks for an indication of a portion of the specification "where it is stated." The question is therefore a new one, and not a repetition of a previous one, to which defendants' counsel alleges he has not received a responsive answer.

Defendants' counsel will change the form of the question, as it appears the witness and counsel for complainants appear to shield the witness from the charge of being irresponsive in his last answer, by reference to the particular form of the question.

Counsel for complainants further asks the attention of the
court to the fact that he has not attempted to "shield" the
653 witness, and does not perceive that he needs any shielding,
but has merely called the attention of defendants' counsel to the difference, in terms, between the two last preceding questions.

(Question 729 withdrawn.)

730 X Q. Will you please indicate, if you can, any portion of the drawing which shows, or the specification of complainants' patent which states, that the "auxiliary valve" 41, which performs the function of admitting compressed air directly from the main air pipe to the brake-cylinder, may be integral with the triple valve, or the main valve of the triple valve?

A. I have built many mechanisms from specifications; in fact, that has been, at times, my principal occupation, and to me, with that experience, the reference I have made to the specification of patent 360,070, states, in substance, that the slide-valve 41 may be integral with any other part.

731 X Q. While I cannot agree with your ingenious answer, and the very remarkable view you take of the two lines in the specification to which you have referred, I will ask you whether it is not a fact that lines 51, 52 and 53 of p. 3 state, that the auxiliary slide-valve 41 is connected to and moves with the stem 36, and I ask you whether the said stem 36 is not entirely separate from the parts of the triple valve?

A. In the particular construction shown in the drawings of patent 360,070, which is only one of many of the constructions that can be built wholly within the specification of patent 360,070, the "auxiliary" slide-valve 41 moves with the stem 36, and stem 36 is separate from the parts which perform the plain triple-valve functions, but, for all purposes of practical operation, stem 36 might just as well be integral with, and a part of, the triple-valve piston.

The last part of the answer, commencing with the words "but for all purposes," is objected to as merely a volunteered statement, and as showing the anxiety of the witness to lug in, at every opportunity, some reference to "integral."

654

732 X Q. Could not X Q. 731 have been responsively and truthfully answered in the affirmative?

A. No, not and tell the whole facts; the question did not state that the particular construction shown on the drawings of patent 360,070 was being inquired about.

733 X Q. X Q. 731 related to but a single fact, and that was, whether or not the said stem 36 is entirely separate from the parts of the triple valve. Is not this so?

Objected to as incompetent, as just what the question relates to may be clear in the mind of counsel, but may have a different meaning either to the court or to the witness, and, therefore, instead of asking the witness what the question relates to, counsel should specifically tell him what it relates to, or what he desires it to relate to, and obtain his answer thereon.

Counsel for defendants objects to objections made by counsel for complainants which seem to have for their object instructions to the witness.

Counsel for complainants is entirely satisfied to submit the question of the propriety and competency of his objections to the better judgment of the court.

(In view of the discussion X Q. 733 is withdrawn.)

Adjourned to Wednesday, January 10, 1894, at 10:30 a. m.

655 NEW YORK, *January* 10, 1894—10.30 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of D. L. BARNES resumed:

734 X Q. I have just observed that you did not give a responsive answer to X Q. 730. I will, therefore, now repeat that question.

Will you please indicate, if you can, any portion of the drawings which shows, or the specification of complainants' patent which states, that the "auxiliary valve" 41, which performs the function of admitting compressed air directly from the main air pipe to the brake-cylinder, *may be integral with the triple valve*, or the *main valve of the triple valve?*

A. The fact that the specification does not state that it shall be non-integral, is quite sufficient instruction to me, based on my experience with specifications, that the auxiliary valve may be integral or non-integral, as it is a really unimportant detail of construction. What is important is, that the auxiliary slide-valve shall be actuated by the further traverse of the piston to perform the auxiliary or fourth function, and that important feature is distinctly specified.

735 X Q. Then, I understand that you cannot indicate anything in that patent which shows or states that the auxiliary valve 41 may be integral with the main valve of the triple valve; but you merely infer that the auxiliary valve may be integral, from the fact that the specification does not state that it shall be non-integral. Is that your position?

A. As you have stated in the question, the specification does not say that the auxiliary valve shall be non-integral, thus leaving it entirely to the mechanical common sense of the designer, as to which construction he shall use.

656 736 X Q. A former question, to wit, X Q. 728, is substantially the same as X Q. 734, the only difference being that the former included the words "either directly or in substance." I observe that you have shifted your position, in giving your answer to X Q. 734, from that which you took in giving your answer to X Q. 728.

In your answer to the former question, 728, you referred to line 51, p. 3, of the specification and line 24, p. 4, of the specification, as indicating to you that the auxiliary valve 41 may be integral. I wish you would explain just how you find, in the matter pointed out at those places in the specification, that the slide-valve may be integral with the main valve of the triple valve, if that is what you mean?

The argumentative matter of the question, being all preceding the words "I wish you would explain," objected to as being irrelevant, immaterial, and a waste of time.

A. My answers to X Q. 728, and X Q. 734 and X Q. 736, I think fully explain what I am now asked about. I will now add, that

POOR COPY

the specification leaves entirely to the designer, the unimportant matter of the detail construction of the auxiliary valve, as well as its location. It may be a part of the main valve, or it may not be. To me the specification is clear and distinct in this matter, and I see no contradiction in my answers to X Qs. 734 and 728, and I think it is manifest that there is none. Any designer of mechanism would not hesitate, under the strictest direction of the specification of patent 360,070, to design and locate the auxiliary valve as his best common sense might direct, provided always that it be so arranged so as to perform the auxiliary function upon the further traverse of the piston. These are the only limitations placed upon the designer in that specification.

737 X Q. Then, in response to the question to indicate, from the drawings or specifications of complainants' patent, your war-
657 rant for stating that the auxiliary slide-valve may be inte-
gral with the main valve of the triple valve, you still refer to the two places in the specification mentioned in your answer to X Q. 728, do you?

A. Yes, sir.

738 X Q. I will quote from the two places, to wit: line 51, p. 3, of the specification of complainants' patent.

"rapidity and full force, and auxiliary slide."

I will also quote line 24, p. 4, of complainants' specification.

"36 and auxiliary slide-valve 41 which instantly."

Do you desire the court to understand that because you have built many mechanisms from specifications, and because of your experience in that line, which you allege to have, you read out of the matter quoted in the two lines just given, a statement which informs you that the slide-valve 41 may be integral with the main valve of the triple valve?

Objected to, as embodying a wholly unwarranted assumption of counsel.

Counsel for defendants protests against the objection of counsel for complainants, because, if the matter stated is unwarranted, the witness is able to see it, and needs not to be instructed in that regard.

Counsel for complainants asks the attention of the court to the waste of time caused by the replies of defendants' counsel, of tenor similar to the last preceding one, it being perfectly obvious that no "instruction" whatever is either afforded or intended by the objection of complainants' counsel.

Counsel for defendants desires to say that he certainly has the right to cross-examine this witness, and to take the necessary time
to do so. And further he must be the judge as to how he
658 will conduct the cross-examination, always with due respect
to the court.

He also desires to point out the fact that this witness consumed six days in giving his testimony-in-chief, and this is but the second day of his cross-examination.

To which complainants' counsel rejoins, that whether this witness as consumed *six* days or *sixty* days, in giving his testimony-in-hief, the length of that deposition is no warrant for cumbering the ecord, and consuming complainants' time, with unfounded and seless replies of the character of that last referred to.

A. I have been questioned about the meaning, in substance, of he lines quoted in the question, and asked as to my warrant for ny opinion, and this I have given so fully that it is not necessary o repeat it here. It is perfectly clear that the lines quoted from he patent in question make no statement as to integrality or non-ntegrality, but the matter is left entirely to the good judgment of he designer, it being really an unimportant detail, which any good nechanic might settle, as I have indicated before.

739 X Q. In your answer to X Q. 730 you state, " ave built nany mechanisms from specifications; in fact, that s been at imes my principal occupation." Do you mean that you have built nechanisms from specifications and drawings furnished by others, vho desired you to build in accordance with such specifications and lrawings?

A. I do.

740 X Q. Then would you not, in such cases, build the required nechanism in accordance with the drawings and specifications fur-nished you as your guide?

A. Certainly I should, and I should always give preference to the pecification. Generally, the drawings are examples of construction nder the specification, of which examples there may be many.
Specifications in general, distinctly state, in terms that can-
59 not be misunderstood, what are the essentials in construction
to follow, and, likewise, leave the non-essentials to the good udgment of the constructor. If it is desired that any part be made eparate from any other part, it would say so, and if it was imma-erial whether they should be separate or not, that would be left to he constructor, in order that he might use his best judgment in onstruction and save expense and complication.

741 X Q. In your answer to Q. 667 you have stated:

" I cannot find that the inventor, in the description and specifica-ion of the device of patent 360,070, conveyed or intended to convey the sense of integrality or non integrality, when referring to and lescribing the auxiliary mechanism which performs the fourth function, namely, quick action."

In view of this statement, all that you have stated elsewhere in your testimony, relative to your belief or opinion that the auxiliary valve 41 may be integral with the main valve of the triple valve, is based on a knowledge you have at this time, or a belief that you have at this time, that quick-action triple valves of the type of patent 360,070 *can* be so made that the air which is admitted from the train-pipe directly to the brake-cylinder, in quick action, will be controlled by a valve which is integral with the main valve of the triple valve. Am I correct about this?

A. You are not correct. My opinion is based solely on the spec-

POOR COPY

ification, and any mechanical engineer accustomed to working from specifications, would, I am confident, understand the specification just as I have explained that *I* understand it.

742 X Q. Have you not stated, in the matter quoted in the last question, from your answer to Q. 667, that "I cannot find that the inventor * * * conveyed or intended to convey the sense
660 of integrality" * * * and, if this is so, how do you reconcile the statement quoted with other statements to the effect that the slide-valve 41 may be integral with the main valve of the triple valve?

Objected to as not proper cross-examination, first, in presenting to the witness a garbled and incomplete extract from his testimony, and second, because the question institutes a comparison between such garbled statement and other statements of the witness, and then asks a reconciliation of them.

Counsel for defendants replies that what counsel for complainants has termed a "garbled and incomplete extract from the testimony of the witness" is really not garbled at all, but is a fair brief, quoting the exact words of the testimony of the witness.

A. My answer to Q. 667 is not properly quoted in the question. I will now quote it, and show that there is not the slightest need of reconciliation:

"I cannot find that the inventor, in the description and specification of the device of patent 360,070, conveyed or intended to convey the sense of integrality or non-integrality when referring to and describing the auxiliary mechanism which performs the fourth function, namely, quick action."

Evidently, if the inventor, in preparing his specification, did not convey the sense of integrality or non-integrality, certainly then "the slide-valve 41 may be integral with the main valve of the triple valve," or it may be non-integral, as the good sense of the mechanical designer may dictate in such an unimportant detail.

If the inventor had wanted or intended to have confined the essential features and characteristics of construction to integral or non-integral constructions, he would certainly have said so
661 in his specification, just as he has defined such features and characteristics as he has considered essential.

There is nothing mysterious or indefinite about my replies, or about the specification. It is a plain, simple mechanical direction about how to construct the essential features and characteristics of a mechanical device.

743 X Q. I understand that your criticism of my question 742, to wit, that your answer to Q. 667 is not properly quoted, is based on the fact that in my question 742, I briefed the quotation which I had made at length in my question 741.

After all that has been said by you on this point of integrality or non-integrality, I understand you simply to mean that, so far as you are concerned, in your reading of the specification of complainants' patent 360,070, and at the same time, leaving out of consideration altogether the claims of that patent, and leaving out of

consideration altogether any legal restrictions or limitations that may be in the claims of that patent, you consider that the specification would warrant you, as a constructor or builder, in making the auxiliary slide-valve 41 either integral or non-integral, just as you chose. Is this right?

Objected to, so far as assuming that the quotation made in X Q. 741 has been fairly or correctly "briefed" in X Q. 742.

Counsel for defendants desires to say that he is utterly at a loss to understand why counsel should, in view of the great value of time to him as heretofore stated this morning on the record, waste time now by the entry of the objection now in question.

A. Your question is a double one. I will answer it as two questions.

The quotation of my statement, in X Q. 742, is not correct, as it does not quote what I said, and I decline to accept such a quotation as expressing my meaning. The quotation is garbled, be-
662 cause it omits important parts of my expressions, and would convey an improper and unwarranted impression of my meaning.

In regard to the second question of this double question, I will say:

1st. My replies to questions on the subject in point do not relate in any way to how I am "concerned," but solely to the subject-matter of the specification of patent 360,070, in which is expressed, in clear language, sufficient for any designer, what it is that the inventor considers is essential to his construction.

2d. I have not considered the claims of patent 360,070, or the "legal restrictions or limitations" of those claims, as that is wholly a matter of law, in which I am not posted or expert, but always refer such questions to counsel.

3d. I do not consider "that the specification would warrant" me, "as a constructor or builder, in making the auxiliary slide-valve 41 either integral or non-integral" just as good common mechanical sense would dictate.

Adjourned to Thursday, January 11, 1894, at 11 a. m.

New York, *January* 11, 1894—11 a. m.

Met pursuant to adjournment.

Present: Counsel as before.

The cross-examination of the witness David Leonard Barnes is here suspended, by consent, to admit of the examination of Selwyn J. Kidder and Frederick M. Nellis.

Selwyn J. Kidder, a witness produced on behalf of complainants, being duly sworn, deposes and says in answer to interrogatories propounded to him by J. Snowden Bell, Esq., of counsel for complainants, as follows, to wit:

663 744 Q. What is your name, age, residence and occupation?

A. Selwyn J. Kidder, residence Chicago, Ill., age 47, occu-

pation locomotive engineer, and the last nine years, railroad traveling engineer and inspector of the Westinghouse Air Brake Company.

745 Q. Please state the nature and extent of your experience as a locomotive engineer and in connection with air brakes for railroads?

A. I was occupied as a locomotive engineer for about fourteen years, as traveling engineer about three years, and for about sixteen years of that time I was intimately connected with the operation and maintenance of air brakes. During the six years that I have been connected with the Westinghouse Air Brake Company I have made a specialty of air brakes.

746 Q. Are you familiar with the construction and operation of the defendants' quick-action triple valve illustrated in plate XI defendants' 1891 catalogue?

A. I am.

747 Q. Have you ever operated, or seen operated, in practical railroad service, a quick-action triple valve similar to that illustrated in said plate XI?

A. I have.

748 Q. I refer you to the following statement, as to the manner of operating the quick-action triple valve of plate XI, defendants' 1891 catalogue, which I quote from page 28 of said catalogue, to wit:

"To apply the brakes, (*not a quick action*) an amount of air is allowed to escape gradually from the train-pipe that will move the piston 29 to unseat the main valve 22 and allow air to pass from the auxiliary reservoir to the brake-cylinder through the same ports as when graduating, and in addition through that one opened by the main valve 22."

As a locomotive engineer, familiar with air-brake practice,
664 please state, with your reasons, whether or not a quick-action triple valve, like that shown in plate XI defendants' 1891 catalogue, can be operated, in practical railroad service, in the manner described in the foregoing quotation?

A. No sir, it cannot. My observations, in noting the performance of this valve referred to, have been that there are but two actions of this valve that can be noted, each movement of which is radical, and results in either a graduated application or in an emergency application.

749 Q. To what peculiarity of structure or operative principle, is due the fact that but two actions of this valve can be noted, resulting, respectively, in a graduated application or in an emergency application, as stated by you in your last preceding answer?

A. In the operation of this triple valve, the graduation takes place resulting from a limited movement of the triple-valve piston, which permits the air to flow from the auxiliary reservoir to the brake-cylinder through the port or passage *i, j, k* in stem 18. If a sufficient reduction of pressure is made in the train-pipe, causing the triple-valve piston to move sufficiently to unseat valve 22, valve 26 is unseated, and air flows directly from the train-pipe to the brake-cylinder, resulting in an emergency application of the brakes.

750 Q. What, if any, practical tests or experiments have been made by you confirmatory of your statement that the quick-action triple valve of plate XI defendants' 1891 catalogue cannot be operated in practical railroad service in the manner specified in the extract from defendants' 1891 catalogue, p. 28, which is quoted in Q. 748?

A. I have experimented with triple valves on moving trains and standing trains, and with a triple valve on a rack, glass discs being inserted in the sides of the triple valve, making it convenient to observe the movement, if any, of the valve 22.

In these experiments in handling trains, I failed to observe any action of the triple valve, other than the two movements before indicated.

In testing this triple valve on a rack, I found it impossible,
665 in making various applications, to get any movement of valve 22, unless a quick action took place, excepting when the train-pipe pressure was reduced below an equalizing pressure which took place in the auxiliary reservoir and brake-cylinder.

751 Q. When and where were the experiments in handling trains, to which you refer in your last preceding answer, made by you?

A. They were made during the months of October and November, 1893, on the Jacksonville Southeastern railway, and I had also made some previous experiments on the Atchison, Topeka, & Santa Fé railroad, perhaps two years ago.

752 Q. Were the results of your experiments on the Atchison, Topeka, & Santa Fé railroad similar to, or different from, that of your experiments on the Jacksonville Southeastern railroad?

A. They were somewhat different, though practically the same. On the Atchison, Topeka, & Santa Fé railroad, the experiments were made on a standing passenger train, a gauge being used on the auxiliary reservoir of one car, from which we could note the variations of pressure in the auxiliary reservoir, and the angle cock or stop-cock at the end of the car was used in lieu of an engineers' brake-valve.

753 Q. When did you first hear any mention of such a proposed or supposed operation of the Boyden quick-action triple valve of plate XI defendants' 1891 catalogue, as is stated in the quotation from said catalogue made in Q. 748?

A. I think it was some four to six months ago when my attention was first particularly called to that which has been quoted.

754 Q. And for how long previous to the time that your attention was first called to the statement quoted, had you been familiar with quick-action triple valves similar to that of plate XI defendants' 1891 catalogue, or been in communication with any persons employed in railroad service who were using such quick-action triple valves?

666 A. I have been familiar with the construction, and, to some extent, the operation of the triple valve referred to, for probably three years past.

755 Q. Have you or not ever known such an operation of the Boyden quick-action triple valve, plate XI defendants' 1891 cata-

logue, as is specified in the quotation therefrom made in Q. 748, to be practiced by locomotive engineers in regular railroad service, or heard it referred to by locomotive engineers as a recognized or known mode of operating such quick-action triple valves?

A. I have not.

Cross-examination by CHARLES B. MANN, Esq., of counsel for defendants:

756 X Q. In the experiments made by you with triple valves on moving trains and standing trains, did the Boyden triple valves have glasses inserted in the sides?

A. No, sir.

757 X Q. Then, as I understand you, you did not actually see how the valve 22 moved in those experiments?

A. Not by observation of the valves themselves.

758 X Q. How did you manipulate the engineers' valve in the experiments you made; did you cause it to make intermittent discharges of air from the train-pipe, or a slow and continuous discharge?

A. Both.

759 X Q. In the case where you manipulated the engineers' valve to produce a slow and continuous discharge of air from the train-pipe, are you sure that the valve 22 did not finally unseat, and admit, say from five to ten pounds, of auxiliary reservoir pressure to the brake-cylinder?

A. Well, I feel sure in my own mind that such a result did not take place.

760 X Q. But can you say positively that it did not?

A. I will say positively in my own mind that it did not.

667 Answer objected to as not responsive to the question, and the question is repeated.

761 X Q. Can you say positively, from any knowledge you have, that the valve 22 did not finally unseat, and admit some auxiliary reservoir air to the brake-cylinder?

A. Well, from my knowledge of the action of air brakes operated by a triple valve of this kind, I should feel justified in positively stating that such a result did not take place.

762 X Q. Will you not admit that where you manipulated the engineers' valve to produce a slow and continuous discharge of air from the train-pipe, in the experiments made on the railroads, the valve 22 might not finally have unseated and admitted from five to ten pounds of auxiliary reservoir pressure to the brake-cylinder without your knowing it?

A. I have no hesitation in saying I do not think such a result could have taken place without my noticing it.

763 X Q. If the particular result, which I have named, had taken place, how could you have noticed it in the experiments made on the railroads?

A. In an experiment of the kind, the retarding force imparted to the train would have been noticeable had the valve 22 been opened

and air discharged from the auxiliary reservoir to the brake-cylinder by this method.

764 X Q. Perhaps you do not understand fully the scope of my question, and I will, therefore, restate it in other words.

In the experiments made by you on the railroads, where you manipulated the engineers' valve to produce a slow and continuous discharge of air from the train-pipe, the question is: after the auxiliary reservoir air had passed to the brake-cylinder, sufficient to produce an equalization between the auxiliary reservoir and brake-cylinder, excepting the last five or ten pounds, might not
668 valve 22 have unseated, and admitted the last five or ten pounds to the brake-cylinder, without your knowing it?

A. With the experiments that I have made, which were quite numerous, where the movement of the valve 22 could be plainly seen, in the case of the triple valve having glasses in the sides, it would appear conclusive to me that such a condition could not take place, as, in making those experiments with the valves with glass sides, my opportunities were of the character to demonstrate very much more fully, that this movement of valve 22 could not be accomplished under the case recited in the question.

765 X Q. Do you think that when applying the brakes, under the conditions stated in the last question, when the auxiliary reservoir air had equalized in the brake-cylinder, excepting the last five or ten pounds, that the addition, to the pressure in the brake-cylinder, of the last five or ten pounds, would produce such an additional retarding force to the brakes of the train as would have been especially noticeable, in the stopping of the train?

A. It would.

766 X Q. While that would be true, you think, if the train were running, I now ask, if, in the same experiments made when the train was standing, you had anything to indicate to you positively that the valve 22 did not unseat at the final equalization and admit the last five or ten pounds?

A. Owing to the changed conditions related, I should conduct experiments of that kind on a little different line. While I might, in the event of the moving train, depend upon certain movements of the train from which to draw my deductions, with the standing train, to demonstrate the performance or non-performance of the valve 22, I should rely on other means to determine whether or not any movement of valve 22 took place.

767 X Q. As to the experiments made about which I am inquiring, that is, those which you made on the railroads where the
669 Boyden valves did not have the glass sides, had you any other means to determine positively whether or not valve 22 unseated on the final equalization, to admit the last five or ten pounds of auxiliary reservoir air to the brake-cylinder?

A. Well, as I didn't make any experiments of that kind, I cannot answer the question.

768 X Q. You say that you have been occupied as a locomotive engineer for about fourteen years. Did you ever have charge of a passenger train in regular service?

A. I did have.

769 X Q. Please state when, and for how long a time.

A. I had experience in handling that class of a train, off and on, during most of that time. This was on the Chicago, Burlington and Quincy railroad.

770 X Q. Were you familiar with the air brakes which were used on passenger trains in regular service run by you prior to 1887?

A. I was.

771 X Q. During your experience as an engineer running passenger trains of five to ten cars, did you ever have occasion to apply the brakes in an emergency, to stop the train in the shortest possible distance, that is, prior to the year 1887?

A. I did.

772 X Q. In running passenger trains prior to 1887, in the case of emergency, did you manipulate the engineers' valve to discharge the train-pipe air intermittently, or slowly and continuously, or did you open the engineers' valve to its fullest extent and leave it open to discharge the air quickly from the train-pipe?

Objected to as not cross-examination, the manner of manipulating the engineers' valve prior to 1887, not having been mentioned or referred to, either directly or indirectly, in the examination-in-chief.

Counsel for defendants states that the witness has testified
670 to his own experience as an engineer, and the question is certainly a proper one, as going to show what his experience and knowledge is.

A. I did not use what is termed an engineers' brake-valve, in handling brakes prior to 1887.

773 X Q. Please state what the engineer did use, prior to 1887, to control the action of the air brakes?

A. What was termed a three-way cock.

774 X Q. In running passenger trains prior to 1887, in the case of emergency, did you manipulate the engineers' three-way cock to discharge the train-pipe air intermittently, or slowly and continuously, or did you open the engineers' three-way cock to its fullest extent, and leave it open, to discharge the air quickly from the train-pipe?

Same objection as was entered to X Q. 772, with the substitution of the words "three-way cock" for the word "valve."

Same rejoinder by counsel for defendants.

A. It depended on the nature of the emergency, whether, in an instance as cited, I would discharge the train-pipe air intermittently, or open the three-way cock to its fullest extent. My usual practice, under such conditions, would be to leave it open to discharge, only a sufficient length of time to assure myself that all the brakes were fully applied.

775 X Q. Then do you wish to be understood as saying, that your usual way, in the case of emergency, of stopping a passenger train in the shortest possible distance, with such triple valves as were used prior to 1887, would be to open the engineers' three-way cock,

and leave it open sufficiently long to assure you that all the brakes were fully applied?

Same objection, and further objected to as irrelevant and immaterial.

Same rejoinder by counsel for defendants.

671 A. Yes.

776 X Q. As you say that you have had long experience in running passenger trains prior to 1887, I will ask you if you were familiar with the triple valves that were then used with the air brakes on passenger trains?

A. I was, from the time the automatic brakes were introduced on the Chicago, Burlington & Quincy R. R., about 1881 or 1882.

777 X Q. Can you identify the kind of triple valve that was used on passenger trains with air brakes, on the C. B. & Q. R. R. between the years 1881 or 1882 and 1887, by pointing the same out in the catalogue of the Westinghouse Air Brake Company, and if your knowledge is sufficient to enable you to do so, I will ask you to look at the catalogue of the Westinghouse Air Brake Company of 1886, on page 33, plate B⁹, and say whether or not the illustration of the valve there shown is one that was in use during the time I have stated?

Objected to as not cross-examination, and defendants' counsel is notified that in persisting in interrogating the witness as to matters wholly foreign to his deposition-in-chief, he makes the witness his own, and that action will be taken accordingly.

Counsel for defendants replies that this witness has been offered to testify, because of his alleged experience as an engineer, and defendants certainly have the right to ask any questions that are calculated to test that knowledge and that experience.

To which counsel for complainants rejoins, defendants' counsel undoubtedly has the right to test the competency of the witness to testify as to the matters regarding which he was asked, and as to which he has answered, in his deposition in-chief, but that he
672 has *no* right to use this witness for a discussion of questions wholly foreign to the deposition-in-chief, and for the apparent purpose of supporting some theory of the defense wholly foreign to the matters testified to in chief by this witness.

A. The triple valve shown in plate B⁹, Westinghouse catalogue 1886, I identify as one of the kind that was used on the road where I was employed from the time of the adoption of the automatic air brakes up to 1887.

778 X Q. Did the trains which you, as an engineer, ran between 1881 or 1882 and 1887 have air brakes which were operated by triple valves such as that shown in the plate B⁹ of the Westinghouse catalogue?

Same objection.

A. A portion of the time, the trains which I handled were pro-

vided with triple valves substantially the same as that shown in plate B^9 of the Westinghouse catalogue.

779 X Q. As you have had no difficulty in identifying the triple valve used at the time inquired about, by reference to the illustration in the catalogue, I will ask you to compare the illustration, plate B^9, with the illustration in patent 220,556, simply for the purpose of informing me whether or not the triple valve illustrated in the patent, is substantially the same as that illustrated in plate B^9

Objected to as not cross-examination and as incompetent, the witness not having been shown to be capable of making the comparison called for.

Counsel for complainants now notifies defendants' counsel tha he does not propose to allow the this witness to be examined as a expert on the part of defendants, relatively to matters wholly
673 foreign to his deposition-in-chief, and instructs the witness t decline to make the comparison called for.

A. I decline to make the comparison, under the instructions o counsel.

780 X Q. In the triple valves, such as you say you had experienc with from 1881 or 1882 to the year 1887, and such as are illustrate in plate B^9 of the Westinghouse catalogue 1886, which you hav identified; when you applied the brakes on passenger trains of fiv to ten cars, for the purpose of making an emergency stop, would or would not, the piston 5 move its full stroke?

Objected to as not cross-examination, irrelevant and immaterial Counsel for defendants enters the same rejoinder as last noted.

A. That would depend upon the rapidity with which the air wa discharged from the train-pipe, and, as before stated, the nature o the emergency.

781 X Q. Where the nature of the emergency was such that yo desired to stop the train in the shortest possible distance, stat whether or not then you would manipulate the engineer's thre way cock so as to cause the piston 5 of the triple valve to move it full stroke.

Same objection.

A. If I manipulate the engineer's three-way cock in a manne to assure myself that the brakes were fully applied, triple-valv piston 5 of plate B^9 Westinghouse catalogue 1886, would move it full stroke.

782 X Q. In applying the brakes equipped with triple valves lik plate B^9 Westinghouse catalogue 1886, to make an emergency sto where it was desired to stop the train in the shortest possible di tance, do you know whether the auxiliary reservoir air woul
674 be admitted to the brake-cylinder through the graduatin valve 7, or by the slide-valve 6, uncovering the port *f*?

Same objection.

A. That would depend upon the rapidity with which the air wa

discharged from the train-pipe, and the length of train upon which the air was being worked continuously.

783 X Q. In applying the brakes of a five or ten car train, as you have no doubt often done, where the cars were equipped with triple valves like plate B[9] Westinghouse catalogue 1886, to make an emergency stop, where it was desired to stop the train in the shortest possible distance, do you know whether the auxiliary reservoir air would be admitted to the brake-cylinder through the graduating valve 7, or by the slide-valve 6, uncovering the port *f*?

Same objection, and counsel for complainants, repeating the notice to defendants' counsel given after X Q. 779, instructs the witness to decline to answer this question, or any further questions relating to plate B[9] of the Westinghouse catalogue of 1886, which was not referred to, directly or indirectly, in the examination-in-chief.

A. I decline to answer this question, under instruction of counsel.

Counsel for defendants states that, as the witness evidently evaded answering responsively X Q. 782, which is exactly the same question as X Q. 783, with the exception that the question last named inquires about a train of five or ten cars; and as the witness answered that question without instructions from complainants' counsel to decline to answer it, this line of cross-examination will not be continued.

675 784 X Q. Are you now in the employ of the Westinghouse Air Brake Company, and if you are, please state how long you have been in that employ?

A. I am, and have been for about six years.

SELWYN J. KIDDER.

FREDERICK M. NELLIS, a witness produced on behalf of complainants, being duly sworn, deposes and says in answer to interrogatories propounded to him by J. Snowden Bell, Esq., of counsel for complainants, as follows, to wit:

785 Q. What is your name, age, residence and occupation?

A. Frederick M. Nellis, age 32, Dennison, Ohio, occupation, locomotive engineer. At present, I am employed as instructor of the Westinghouse Air Brake Company's instruction car.

786 Q. How long have you been in the service of the Westinghouse Air Brake Company?

A. About five years.

787 Q. Please state the nature and extent of your experience as a locomotive engineer and in connection with air brakes for railroads?

A. I first served a regular three-years apprenticeship at the machinists' trade, at the Pittsburgh, Cincinnati and St. Louis Railway shops, Dennison, Ohio, after which I fired three years on that road, ran a locomotive for two years on the same road, was traveling engineer for the Pittsburgh locomotive works for two years, and, for the past five years, have been engaged by the Westinghouse Air

Brake Company, all of which time I have had more or less to do with air brakes.

788 Q. Are you familiar with the construction and operation of the defendants' quick-action triple valve illustrated in plate XI, defendants' 1891 catalogue?

A. I am.

676 789 Q. Have you ever operated, or seen operated, in practical railroad service, a quick-action triple valve similar to that illustrated in said plate XI?

A. I have.

790 Q. I refer you to the following statement, as to the manner of operating the quick-action triple valve of plate XI, defendants' 1891 catalogue, which I quote from page 28 of said catalogue, to wit:

"TO APPLY THE BRAKES FULLY, (*not a quick action*) an amount of air is allowed to escape gradually from the train-pipe that will move the piston 29 to unseat the main valve 22 and allow air to pass from the auxiliary reservoir to the brake-cylinder through the same ports as when graduating, and in addition through that one opened by the main valve 22."

As a locomotive engineer, familiar with air-brake practice, please state, with your reasons, whether or not a quick-action triple valve like that shown in plate XI, defendants' 1891 catalogue, can be operated, in practical railroad service, in the manner described in the foregoing quotation?

A. In my opinion, it cannot. I have tried, in practical service, and also on a rack, to obtain this alleged application, but in both instances have failed to get it.

791 Q. As a result of your trials, both in practical service and on a rack, please state what applications, and *only* what applications, of the brakes can be made, in practical railroad service, by defendants' quick-action triple valve, defendants' plate XI, 1891 catalogue?

A. Only two applications. The ordinary service or graduating application, and the quick-action application.

792 Q. To what peculiarity of structure, or operative principle, of defendants' quick-action triple valve, plate XI defendants' 1891 catalogue, is the fact due that only two applications of the brakes can be made by said valve in practical railroad service, to wit:
677 the ordinary service or graduating application and the quick-action application, as you have stated is the case in your last preceding answer?

A. The valve is so constructed that a gradual reduction of pressure in the train-pipe will allow the main piston to move, and permit pressure from the auxiliary reservoir to pass through port *i*, *j*, *k*, in the stem 18, to the brake-cylinder. A quick-action application of the brakes is had by reducing the train-pipe pressure suddenly, and permitting the main piston to travel its full stroke, which opens up valves 26 and 22, allowing train-pipe pressure to flow to the brake-cylinder, the auxiliary reservoir pressure also going to the brake-cylinder

793 Q. Under such construction, what is the result, in practical railroad service, of lifting the valve 22 from its seat?

A. The lifting of valve 22 from its seat, will allow train-pipe pressure to flow into the brake-cylinder, unless a full service application has been had.

794 Q. If a full service application has been had, what, if any, useful result is obtained, in then, or thereafter, lifting or unseating valve 22?

A. There is no practical or useful result obtained, because the pressures have already become equalized.

795 Q. What practical tests or experiments were made by you, confirmatory of your statement that the quick-action triple valve of plate XI defendants' 1891 catalogue cannot be operated in practical railroad service in the manner specified in the extract from defendants' 1891 catalogue, page 28, which is quoted in Q. 790, and that only two applications, to wit, the ordinary service or graduating and the quick-action, can be made in practical railroad service by said quick-action triple valve?

A. I have made two series of tests, one on moving trains, and another on a rack. The experiments on moving trains were made on the Jacksonville Southeastern railroad, on October 26th and November 22d, 1893.

In the first test of moving trains there were three cars, one
678 equipped with the Boyden quick-action triple valve, and two
with the Westinghouse plain triple valves. The second test made on moving trains, was made with three cars, all equipped with the Boyden quick-action triple valve.

I made several applications of the brakes, with a view of satisfying myself whether this alleged application referred to could be had, but in every instance, failed to get it. I worked the engineer's brake-valve so as to discharge the air in the manner stated in the catalogue, and made every effort to get this alleged application, but failed to do so. Each application resulted either in a distinct service application or a quick-action application. It is plain to me that this alleged application referred to cannot be had, as my experiments have satisfied me on that point.

The experiments made on the rack with the quick-action valve referred to, were made with the equalizing brake-valve and the ordinary stop-cock, and with a Boyden quick-action triple valve, like that shown in plate XI of defendants' 1891 catalogue, having glass sides, which showed the movement of valve 22. In all experiments made, a service application, obtained as before described, or a quick-action application, followed.

I made special effort to obtain this alleged application, but failed in every instance to get it.

Adjourned to Friday, January 12, 1894, at 10.30 a. m.

New York, *January* 12, 1894—10.30 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of F. M. Nellis resumed:

796 Q. When did you first hear any mention of such a pro-
679 posed, or supposed, operation of the Boyden quick-action triple valve of plate XI defendants' 1891 catalogue, as is stated in the quotation from said catalogue made in Q. 790?

A. About three months ago.

797 Q. And for how long previously had you been familiar with quick-action triple valves similar to that of plate XI defendants' 1891 catalogue, or been in communication with any persons employed in railroad service who were using such quick-action triple valves?

A. For about three years I have been intimate with the working of said triple valve, so far as could be gained from the catalogue mentioned, but the information I have had of the operation of this triple valve in service, has been from men operating it in service, and has been during the last three months. I have frequently heard of the operation of this kind of triple valve, but have never heard of this alleged operation referred to in the extract from the catalogue.

798 Q. Have you, or not, ever known such an operation of the Boyden quick-action triple valve, plate XI defendants' 1891 catalogue, as is specified in the quotation therefrom made in Q. 790, to be practiced by locomotive engineers in practical railroad service?

A. I have not, and believe that, if said operation was known and performed, I would surely have heard of it, having been so intimately associated with these men handling air brakes in practical railway service.

Cross-examination by Charles B. Mann, Esq., of counsel for defendants:

799 X Q. In answer to Q. 792 you state that

"A quick-action application of the brakes is had by reducing the train-pipe pressure suddenly and permitting the main piston to travel its full stroke, which opens up valves 26 and 22, allow-
680 ing train-pipe pressure to flow to the brake-cylinder, the auxiliary reservoir pressure also going to the brake-cylinder."

When a quick application of the brakes is had, does the auxiliary reservoir pressure in going to the brake-cylinder, as you state, pass through the port opened by the valve 22?

Objected to as irrelevant and immaterial.

A. In a quick-action application of the brakes the pressure from the auxiliary reservoir going to the brake-cylinder, passes through port opened by valve 22.

800 X Q. Then your answer is, yes, is it not?

A. It is.

801 X Q. You have testified in answer to Q. 795, that you made ;o tests on moving trains on the Jacksonville Southeastern rail-oad, to try the Boyden quick-action triple valve, and that, in every istance, you failed to get the result you were looking for, namely, ie lifting of valve 22 from its seat, when trying to apply the brakes lly with auxiliary reservoir air.

How do you know, *for a certainty*, that, in these two tests, the alve 22 did not lift from its seat and admit some auxiliary reser-oir air to the brake-cylinder?

A. I do not know for a certainty that there was no auxiliary eservoir air admitted to the brake-cylinder, in making these appli-ations of the brakes, but the results had from these applications ere like those had from a plain service application, or a quick-etion application of the brakes. If any pressure from the auxiliary eservoir did pass to the brake-cylinder, from the lifting of the valve 2, it was of little consequence, and had no material effect upon ie brakes.

802 X Q. As an instructor of air brake operations, I want to ask you consider yourself thoroughly acquainted with all the various operations of the different parts of the air brakes, and whether
81 you consider yourself skilled in the handling of air brakes in practical service?

A. I do consider myself a competent instructor, believing that I ave a thorough practical knowledge of the air brake and its oper-tions. I also believe I am a skillful handler of air brakes on rains.

803 X Q. As an instructor of air-brake operations in the employ f the Westinghouse Air Brake Company, are you familiar with the perations of the q ck-action triple valve now used, and the plain riple valve which is still used?

A. I am.

804 X Q. Please look at the Westinghouse catalogue, 1890, plate)[1], entitled "The Westinghouse quick-action automatic brake," nd at the triple valve illustrated under the head of "tender," and tate whether or not the triple valve referred to, is a plain triple alve, such as referred to in my last preceding question?

A. The triple valve referred to is such as I know by the name of plain triple."

805 X Q. I will also ask you to look at the same catalogue (1890), n page 32, and state whether or not plate D^{20} illustrates the same ind of triple valve last referred to, namely, that which is now used n tenders?

A. This is also a "plain" triple valve, such as is now used on enders and locomotives.

806 X Q. I will also ask you to please look at Westinghouse cat-logue 1886, page 33, plate B^9, and state whether or not it shows a plain triple valve, such as last inquired about and now used on enders?

A. This is also a "plain" triple valve, such as is used on locomotives and tenders, and similar to those previously referred to.

807 X Q. I will ask you about the action of the plain triple valve. Suppose an engine and tender, equipped with plain triple valves like plate B[9] Westinghouse catalogue 1886, and plate D[20] catalogue 1890, and suppose such an engine and tender were connected
682 to a train of fifty cars, equipped with quick-action triple valves, and an emergency application of the brakes was made, would not the pistons of the plain triple valves on the locomotive and tender, move their full stroke, and thereby admit auxiliary reservoir air to the brake-cylinder, through the port uncovered by the slide-valve?

Objected to as irrelevant and immaterial, and as not proper cross-examination, not having reference to any matters referred to in the examination-in-chief.

A. If the train were so equipped, and an application made as you describe, the triple-valve pistons of the tender and locomotive would travel their full stroke, and permit auxiliary reservoir pressure to pass to the brake-cylinder through ports uncovered by the slide-valves.

808 X Q. Suppose the same conditions of locomotive, tender, and train, equipped with plain triple valves and quick-action triple valves, as stated in the last question, to exist, and it was desired to apply the brakes for a service stop, would not the pistons of the plain triple valves on the locomotive and tender make only a partial stroke, and thereby admit auxiliary reservoir air to the brake-cylinder by the graduating valve, which, in plate B[9] Westinghouse catalogue 1886, is designated 7?

Same objection.

A. If on a locomotive and tender equipped with plain triple valves, and a fifty-car train equipped with quick-action triple valves, it was desired to have a service application of the brakes, a gradual reduction of pressure in the train-pipe would cause the pistons of the plain triple valves on the locomotive and tender to travel part of their stroke, and permit pressure from the auxiliary reservoir to flow through graduating port 1 to the brake-cylinder.

683 809 X Q. Then I understand that your answer is yes; am I right?

A. You are right.

810 X Q. Then I understand by your testimony that the Westinghouse plain triple valve has two valves, to admit auxiliary reservoir air to the brake-cylinder, one of which is opened by the preliminary traverse of the piston, while the other is opened by the complete traverse of the piston; is this right?

Same objection, and counsel for complainants, repeating the notice to defendants' counsel given after X Q. 779, instructs the witness to decline to answer this question, or any further questions relating to the plain triple valves of the Westinghouse Air Brake Company's

catalogues, which were not referred to, directly or indirectly, in his examination-in-chief.

A. I decline to answer the question, under instructions of counsel.

Counsel for defendants protests against and objects to the instruction of complainants' counsel to the witness, that he shall decline to answer:

First, because counsel for defendants has the right to test the knowledge and competency of the witness, who has testified as an expert fully acquainted with the practical operations of triple valves for air brakes.

Second, because the question which the witness has been instructed not to answer, and other questions to follow, would, if answered truthfully, be instructive to the court, and would tend to show that the defendants are not trespassers and infringers on the rights of complainants.

684 Third, because the said instruction, although apparently based on the ground that the question is not a proper one on cross-examination, will, in reality, have the effect to prevent a disclosure of the knowledge this witness possesses as to the real action of triple valves, and will thus suppress the whole truth.

To which counsel for complainants rejoins:

First. That while it is true that the witness has testified as an expert "fully acquainted with the practical operations of triple valves for air brakes," he has been examined, and has testified, only as to the operation of the defendants' quick-action triple valve, and has given no testimony whatever, in chief, relatively to the plain triple valves of the Westinghouse Air Brake Company's catalogues. If counsel for defendants desires, as he alleges, "to test the knowledge and competency of the witness," he has an ample opportunity to do so by inquiries as to the operation of the mechanisms, or other mechanisms, of the class as to which he has testified.

Second. That the witness has not been examined in chief, and is not here, "to show that the defendants are not trespassers and infringers on the rights of complainants," and that whatever evidence defendants desired to offer in that regard should have been offered in their own testimony; they have no right to seek to use complainants' witness as an expert on their behalf, by inquiries irrelevant to the testimony-in-chief.

Third. That "the whole truth" as to the matters testified to by the witness in chief may be obtained, in the event of its not having been already stated, by interrogatories, on the part of defendants' counsel, relevant to such matters as were testified to in chief.

685 Counsel for defendants states that, as the witness has declined, under instructions from complainants' counsel, to answer the last question, the cross-examination will not be continued.

F. M. NELLIS.

Cross-examination of DAVID LEONARD BARNES resumed:

811 X Q. You have stated that the function of a valve is the purpose or office. Does not valve 22, of defendants' quick-action triple valves, serve the purpose or office of admitting auxiliary reservoir air to the brake-cylinder, at the same time that it is admitting train-pipe air to the brake-cylinder, in producing a quick-action application of the brakes?

A. Valve 22 does not control the admission of air from the auxiliary reservoir to the brake-cylinder when a quick-action application is made. The control is wholly by the restricted passage B, which corresponds to the restricted passage 35 of complainants' valve.

The answer is objected to as not responsive to the question and as being evasive of the question.

312 X Q. You were not asked, in the last question, whether the "*valve 22 does not control the admission of air.*" X Q. 811 repeated.

A. The function inquired about is that of admitting auxiliary reservoir pressure to the brake-cylinder. This function is regulated, in a service application, by the ports *i, k, j*, and in a quick-action application, by the port B. If the valve 22 did not lift from its seat, this function would be performed and regulated by the ports *i, k, j*. The opening of the valve 22 gives a larger passage from the chamber C to the brake cylinder, but it can admit no more air from the auxiliary reservoir than will pass through the passage B, although the passage opened by valve 22 is enormously larger than
686 passage B, hence the control of the admission, which is the equivalent to the regulation of the admission, and is the function, and the necessary function, to be performed, with respect to the auxiliary reservoir pressure, at the time of quick action, is all performed by passage B. Any other passage leading from the cavity C to the brake-cylinder would answer just as well as the passage opened by valve 22, and its size would be immaterial, so long as it is larger than B.

Valve 22, like many parts of compound mechanisms, has a principal function for which it is designed, also several minor functions which it performs incidentally; the minor functions, therefore, are incidental functions, which are allotted to the different parts as a matter of convenience, or for some other practical purpose.

The case of valve 22 is about like this: It has a principal function of admitting the air from the train-pipe to the brake-cylinder, at the time of quick action, and it has the incidental function of opening a larger passage from the cavity C to the brake-cylinder, thus rendering the cavity C, practically a part of the brake-cylinder, thus permitting the auxiliary reservoir pressure to flow more freely from the restricting and controlling point B to the brake-cylinder, and to this extent, and to this extent only, has valve 22 any function whatsoever, with respect to the auxiliary reservoir pressure. On the other hand, the function of admitting auxiliary reservoir pressure to the brake-cylinder, at the time of quick action, and the complete and full control of this function, is performed by the passage B; there-

fore, it is clear that the function of admitting the auxiliary reservoir pressure to the brake-cylinder, at the time of quick action, is performed by the passage B, that being the only function of passage B, hence such function cannot be performed by valve 22. It would be misleading to say that valve 22 serves "the purpose or office of admitting auxiliary reservoir air to the brake-cylinder at the same time that it is admitting train-pipe air to the brake-cylinder,
687 in producing a quick application of the brakes," and yet, when valve 22 is opened, the air from the auxiliary reservoir passes through the passage opened by valve 22, but it is not in any way controlled by that passage, but is wholly controlled by the restricted passage B.

Counsel for defendants objects to the answer because it is evasive, not responsive and, at the outset, misstates the inquiry to which the question relates. The answer is apparently an endeavor on the part of the witness to muddle the subject inquired about, instead of making it clear.

813 X Q. The question is now repeated, as follows:

Does not valve 22, of defendants' quick-action triple valves, serve the purpose or office of *admitting auxiliary reservoir air to the brake-cylinder, at the same time that it is admitting train-pipe air to the brake-cylinder, in producing a quick-action application of the brakes.*

Will you be kind enough to answer this question, omitting the irrelevant matters?

A. If the "office" or "purpose" of a part is the "function" which it controls, then I answer, no; but if the "office" or "purpose" is assumed to be a function which it does not control, then, to that extent, and that extent only, do I answer, yes.

If I am confined to a categorical answer, then I say, no, with the distinct understanding that my answer is to be taken together with the explanation I have given in this and the last preceding answer.

Counsel for defendants objects to the answer as an apparent endeavor to evade.

814 X Q. I will vary the question a little, and put it again, as follows:

When a quick application of the brakes is had, does the auxiliary reservoir pressure, in going to the brake-cylinder, pass through the port opened by the valve 22?

688 A. Yes.

815 X Q. When a quick application of the brakes is had with the valve shown in the drawings of complainants' patent, does the auxiliary reservoir pressure, in going to the brake-cylinder, pass through the port opened by the auxiliary valve 41?

A. No.

816 X Q. Are not two valves employed in the quick-action valve shown in the drawings of complainants' patent 360,070, to produce a quick action of the brakes—one of which is the auxiliary valve 41 to admit the train-pipe air to the brake-cylinder, and the other is

one of the triple valves to admit auxiliary reservoir air to the brake-cylinder?

A. I ask for further light on this question. In what sense is the term "triple valves" used in the question, and is the question confined strictly to the single illustration of one of the many constructions possible under the specification of patent 360,070?

Counsel for defendants states that it would seem that no further light on the question were needed, inasmuch as the term "triple valves" clearly has reference to a triple valve that will functionate, as stated in the question, "*to admit auxiliary reservoir air to the brake-cylinder.*" The question also states that the inquiry is "*confined*" to the quick-action triple valve shown in the drawings of complainants' patent 360,070.

817 X Q. I will now repeat the question:

Are not two valves employed in the quick-action valve shown in the drawings of complainants' patent 360,070, to produce a quick action of the brakes—one of which is the auxiliary valve 41 to admit the train-pipe air to the brake-cylinder, and the other is one of the triple valves to admit auxiliary reservoir air to the brake-cylinder?

689 Will you please answer the question, in view of the "further light" stated in the explanation made by me?

A. "To produce a quick action of the brakes" of the device shown in the *drawings*, a further traverse of the piston is employed. To permit quick action to take place, there is an auxiliary valve and a restricted passage, just as in defendants' valves. As I have said before, it is indefinite to refer to the names of parts, unless such names define definitely the function of the parts. For all intents and purposes of practical operation, a restricted passage becomes a valve when it controls the admission of a fluid, and passage B of defendants' device is an example of this.

Two valves may be combined in one part or piece and yet be two valves, or they may be separate in structure and still be two valves.

No; quick action is *produced* by the further traverse of the piston.

Counsel for defendants objects to the answer, as an apparent endeavor to evade the real question, and as not being a response to the question.

818 X Q. As a mechanical engineer, do you make the remarkable statement that a restricted passage, or any passage, which is always open and in condition to pass fluid, is a valve?

A. Yes, when it performs the functions of a valve. Valves are used not alone to stop the flow of fluids, but to restrict their flow, and, when a valve is so used, it is the equivalent of a restricted passage.

The witness has begged the question entirely, as the statements in the last answer contain qualifications not stated in the question nor stated in his previous answers.

690 Counsel for complainants desires that it be noted that the foregoing remarks were made by defendants' counsel.

819 X Q. As you are the only person whom I have ever known to designate the passage B of defendants' quick-action triple valve as "*a valve*", and as none of the witnesses in this case have heretofore termed it a valve, or as having the function of a valve, and as you have not heretofore so called it, or referred to it as having the functions of a valve, but do so now for the first time, I ask you what is your warrant for now calling it a valve?

Objected to, because embodying the erroneous assumption that the witness has designated, termed, or called, the passage B "a valve."

Counsel for defendants replies that complainants' counsel, in his effort to help the witness, has overlooked this statement in the answer of the witness to X Q. 817.

"For all intents and purposes of practical operation, a restricted passage becomes a valve when it controls the admission of a fluid, and passage B of defendants' device is an example of this."

Counsel for complainants, while here, as heretofore, of the opinion that argument on the record is unprofitable, deems it proper to rejoin that he has not as yet perceived that the witness has stood in need of help from him or from any one else, and has made no effort whatever in that direction. He has by no means overlooked the quotation from answer 817, made in the reply of defendants' counsel, and also has fully in mind the witness' answer to X Q. 818, and, in view of those answers, considers that the statements of the witness, as to the equivalency, under certain conditions, of a restricted passage and a valve, are no warrant whatever for the allega-
691 tion of defendants' counsel that the witness has *designated, termed* or *called* a restricted passage a "valve."

A. As I have explained in answer to X Q. 818, one of the functions, and in fact, one of the principal functions of a valve, is to restrict the flow of fluids, and I now refer counsel to complainants' Record, page 560, folios 2239 and 2240, wherein is described the function of a restricted passage like passage B, having the function of restricting the flow of fluids, and to page 571, folio 2282, where I have referred to the passage B as having the function of passage 35, complainants' device; likewise to page 577, folio 2207, and to other parts of my testimony. It is clear, then, that the question is in error in stating that I have not before said that passage B has the function of restricting the flow of fluid, which I now say, as I did in answer to X Q. 818, is one of the principal functions of a valve.

I have not said that the passage B is a valve, but only that, in restricting the flow of fluids, for all intents and purposes of practical operation, it becomes a valve.

Especially is this true in the case of passage B, which is made of a specific area, with reference to the passage uncovered by the opening of valve 22, which specific area performs no useful purpose, except to act as a valve to restrict the flow of auxiliary reservoir pressure, when the valve 22 is opened for the performance of quick action, and this only upon the further traverse of the piston.

820 X Q. Do you desire the court to understand that the passage

B of plate XI, defendants' 1891 catalogue, as used in the structure there shown, is a valve?

A. Only in the sense that it has the function of a valve that I have defined, namely, the function of restricting the flow of fluids.

821 X Q. Has not the nozzle of a hose pipe a restricted passage?

A. Yes.

692 822 X Q. Does not the restricted passage of the nozzle of a hose pipe perform a useful function?

A. Yes.

823 X Q. Because the nozzle of a hose pipe has a restricted passage which performs a useful function, does it therefore functionate as a valve?

A. Only in that it has one of the functions performed by valves, namely, that of restricting the flow of a fluid.

Take the case in point, a hose attached to a street-main hydrant. If the valve in the hydrant is opened wide, the flow is restricted by the nozzle of the hose; if the valve in the hydrant is partly opened, the flow is restricted by the valve; thus they do have the same and identical function of the restriction of a fluid.

824 X Q. If the nozzle of a hose pipe has the function of a valve, as you say, why, then, do they not use a valve on the end of a hose pipe instead of the nozzle?

Objected to as irrelevant and immaterial, which objection is continued, without further notice, as to the entire line of examination on the subject of hose pipes.

A. They did; I have used them so myself.

825 X Q. I call your attention to port 35, in the slide-valve shown in the drawing of complainants' patent 360,070, and ask you if it is not opened and closed by the movement of the said slide-valve, and does it not, by reason of such opening and closing, functionate as a valve?

A. No; as the function of a valve, with respect to opening and closing something, is this:

A valve opens and closes a port, or permits a port to perform its function, and I cannot see how port 35 can open itself.

Port 35 manifestly and clearly has but the single function as a port or passage, and as a restricted port or passage, to admit
693 air from the auxiliary reservoir to the brake-cylinder, just as
is done by port B, and in the same sequence, with respect to other operations of a quick-action triple valve, and upon the further traverse of the piston.

826 X Q. Then I understand you to say, in response to the first part of my question, which asks you if port 35 "is not opened and closed by the movement of the said slide-valve," that your answer is, "no." Is this the way you desire your answer to stand?

A. Port 35 is for the purpose of admitting auxiliary reservoir air to the brake cylinder, and is *always open to the auxiliary reservoir air.* It is the port 23 that is open and closed, by the movement of the main valve 14, between the auxiliary reservoir and the brake-cylinder. Passage 35 is permitted to perform its useful function, upon

the further traverse of the piston, in complainants' device, just as passage B is permitted to perform its useful function, in defendants' device, upon the further traverse of the piston.

827 X Q. You say true enough, that port 35 is *always open to the auxiliary reservoir air*, but is it not true, that port 35 is opened and closed to permit the passage of auxiliary reservoir air, and to prevent the passage of that air, in just the same measure as port 23, which you have referred to?

A. Port 35 is *always* open to auxiliary reservoir air, and in this way distinctly differs from port 23, which is not.

Auxiliary reservoir air is permitted to pass through the port 35, upon the opening of passage 23 by the valve 14, upon the further traverse of the triple-valve piston. In order that the resemblance between the port 35 and the port B may not be misunderstood from my testimony, I will now compare them as to details.

First. Ports 35 and B are always open to auxiliary reservoir air.

Second. Ports 35 and B have the same specific area, with reference to the large ports opened by the auxiliary valves 41 and 22, for the same specific purpose of restricting the auxiliary
694 reservoir pressure; the specific dimensions being about one-eighth of an inch in diameter for ports 35 and B, and about one inch in diameter for ports uncovered by valves 41 and 22. The areas of these diameters represent the comparative areas of the respective openings approximately.

Third. During the performance of the three triple-valve functions prior to 1887, ports 35 and B are absolutely inert and have no useful purpose. The port 35 might be removed, and the port B destroyed, by the removal of the ring 9 of defendants' device, without interfering with, or destroying, either of the three functions of the triple valves prior to 1887.

Fourth. Ports 35 and B are brought into useful and practical operation, only upon the further traverse of the piston.

Fifth. Ports 35 and B have the single function, and the single and only useful purpose, of restricting the flow of auxiliary reservoir air to the brake-cylinder, at the time of quick action.

Sixth. The single difference between the ports 35 and B lies in the location, with respect to other parts. This incidental arrangement of passage B so locates it that the auxiliary reservoir air passes through it, but is in no way controlled or effected by it, during the performance of the three triple-valve functions prior to 1887.

No; port 35 is always open to the auxiliary reservoir air, and for the passage of that air upon the further traverse of the piston, when port 23 is opened to the brake-cylinder.

Counsel for defendants objects to the answer, as being a long volunteered statement, concerning matters not inquired about in the question. The question calls for no consideration at all, of the passage B in defendants' triple-valve device.

Counsel further objects to the conduct of the witness in appar-

ently endeavoring to evade a square answer to the questio
695 propounded to him. Objection is further made that th
answer is not responsive.

828 X Q. X Q. 827 is repeated.

A. I replied "no," in my last answer, and I again make the sam
reply, for the reasons given.

829 X Q. The witness is requested to indicate where the answ
"no," which he professes is a responsive answer to the questio
occurs in his answer.

A. At the beginning of the last paragraph.

830 X Q. I now repeat X Q. 827.

"You say true enough, that port 35 is *always open to the auxilia
reservoir air*, but is it not true, that port 35 is opened and closed t
permit the passage of auxiliary reservoir air and to prevent th
passage of that air in just the same measure as port 23, which yo
have referred to?"

And I will now also quote the "no," where it occurs in the la
paragraph, and will also quote the paragraph:

"No; port 35 is always open to the auxiliary reservoir air, an
for the passage of that air upon the further traverse of the pisto
when port 23 is opened to the brake-cylinder."

I now ask you if you desire the court to understand that the an
swer quoted is a full and fair response to the question.

Objected to by reason of the misstatement that "the answer" ha
been quoted, the fact being, that, as the record will show, only th
last paragraph of the answer has been quoted.

A. Yes; and I will further add an example to further illustra
the truth of my answer.

696 Let there be a reservoir, and a passage leading from it;
the passage is always open, then there will always be mo
or less of the fluid or pressure that is in the reservoir, in the pa
sage. If the passage is opened and closed, then, sometimes the
will be reservoir fluid or pressure in the passage, and at other tim
there will not be. Manifestly, the passage 35 is always open,
there is always reservoir fluid and pressure in that passage.

Adjourned to Saturday, January 13, 1894, at 10 a. m.

NEW YORK, *January* 13, 1894—10 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of D. L. BARNES resumed:

Counsel for defendants objects to all that part of the last answ
after the first word "yes," as not being responsive to the questio
and as showing a disposition on the part of the witness to lug
irrelevant matter.

831 X Q. Is it not true, respecting both port 35 and port 23, th
it is the movement of the slide-valve 14 which permits either

these ports to pass the auxiliary reservoir air to the brake-cylinder, when making a quick-action application of the brakes?

A. I do not understand the question.

832 X Q. Please state wherein you do not understand the question; it seems to be a plain one for a mechanical engineer, skilled, as you say you are.

A. A port permits the air to pass, but I do not understand how a port can pass the air. It is the pressure of the air itself that passes it. If the counsel wishes to know if the movement of the
697 slide-valve permits air to pass through the port 35 and port 23, then I answer, yes.

It may make my meaning clearer to counsel, regarding this question of the always-open nature of port 35, if I show an example in the case of the slide-valve 14, where there is a port through that valve that is not always open. Port 31 is such a port. It, like port 35, performs the second function of plain triple valves prior to 1887, but differing from port 35, it is not always open, as it is opened and closed by valve 29.

The active principle which passes the air, is not the inert port, but the air pressure.

833 X Q. It seems to me that your attempt to draw a distinction, or to discriminate respecting the capability of the *ports to pass the air*, and the *movement of the slide-valve permitting air to pass the ports*, is a mere play upon words.

I will now call your attention to your statement made in your examination-in-chief, in Complainants' Record, p. 593, under folio 2372, as follows:

"(*c*) The only function of port 35, its office and purpose, is the second function of triple valves prior to 1887, namely, that of admitting air from the auxiliary reservoir to the brake-cylinder. It has no other function, and can have no other, as is manifest from its construction, and its location in relation to other parts."

Is not this a correct quotation from your testimony, and have you not here stated, in substance, that the port 35 is a valve having the function of triple valves, namely, to admit air from the auxiliary reservoir to the brake-cylinder?

Objected to as irrelevant, immaterial and uselessly consuming time, the first paragraph being merely a criticism of the testi-
698 mony of the witness, and so much as constitutes a question relating to a fact which will be self-evident from an inspection of the record.

Counsel for defendants replies that the question now put to the witness is relevant and is material, because it will afford him an opportunity to explain what appears to be an inconsistency between the testimony given on page 593 in his examination-in-chief, and that which he has given in his last few answers in his cross-examination.

A. The quotation is correct.

I have not said that port 35 is a valve.

834 X Q. Have you not said that the "function of a valve is its purpose or office"?

A. I have.

835 X Q. Did you not state, in the matter quoted in my X Q. 833; "the only function of port 35, its office and purpose, is the second function of triple valves prior to 1887"?

Counsel for complainants strenuously objects to this utterly useless repetition of verbatim quotations from the testimony of the witness, as shown by the record, with questions to him as to whether or not he stated what the record *shows* he stated.

Counsel for defendants replies that it is his privilege and duty to criticise the testimony of the witness given in his examination-in-chief, and if he sees what appears to him to be inconsistencies of statement, to call the attention of the witness to the same, in order that he may have an opportunity to explain the same, if he can. Counsel for defendants, therefore, insists that this line of examination is *not* "utterly useless."

To which counsel for complainants rejoins that he has made no objection whatever to the "line of examination," but to the
699 utterly useless questions to the witness, as to whether or not
he stated what the record *shows* that he stated. Defendants' counsel can call the attention of the witness to any statements that he made, and have him compare them, or reconcile them, if counsel supposes them to be contradictory, but it is simply idle, and a waste of time, to ask him whether he *did* so state.

A. Yes.

836 X Q. In view now of your admitted statements quoted in X Q.'s 833, 834, and 835, how do you wish to be understood respecting the port 35? Has it the function of a triple valve, and yet do you deny that it is a valve, in the sense of performing the *purpose* and *office* of a valve?

A. I wish to be understood as follows:

Port 35 is not a valve.

Port 35 has not the functions of a triple valve, as a triple valve is a compound mechanism.

Port 35 has one of the functions of a valve, namely, to restrict the flow of fluid pressure, but this does not make it a valve.

An illustration is found in the case of a broom and a shovel. Both may have the office of cleaning a street, but having the same function, does not make a broom a shovel.

837 X Q. I am at a loss to understand your conflicting statements. In your last answer you say that "*port 35 has not the functions of a triple valve,*" while in your statement made on p. 593, quoted in my X Q. 833, you say *the only function of port 35 is the second function of triple valves.* I confess I cannot understand these conflicting statements. Perhaps you can explain them. If you can, please do so.

Objected to as assuming that there was any conflict between the statements of the witness quoted.

700 A. The function of a triple valve, *per se*, is to apply and release the brakes. The function of port 35 is the second function of triple valves, namely, to admit air from the auxiliary reservoir to the brake-cylinder.

Counsel for defendants objects to the answer, as in no way explaining the apparent conflict between the two particular matters stated in the last X Q.

Counsel for complainants suggests that defendants' counsel must not be surprised if the witness fails to accord with the ideas that defendants' counsel may have, as to suppose conflict between matters stated in the witness' answers.

838 X Q. When making a quick-action application of the brakes, of the device shown in the drawings of complainants' patent 360,070, are not two valves brought into action to perform their functions, to wit, one, which is the auxiliary valve 41, which opens to admit the train-pipe air to the brake-cylinder, and the other, the slide-valve and port 35, which opens to admit auxiliary reservoir air to the brake-cylinder?

A. In the particular example of the construction, under the specification of patent 360,070, that is shown in the drawings of patent 360,070, the auxiliary valve 41, is, as I have repeatedly said before, non-integral with the main valve 14, and in that particular construction, the valve 14 opens port 33 to the brake-cylinder from the auxiliary reservoir, but port 35, as I have said before, is always open to auxiliary reservoir air. Hence, in the particular construction shown in the drawings of patent 360,070, there are two separate valves used to perform the fourth function, but under the specification of patent 360,070, the two valves might as well be integral in one structure.

839 X Q. Then, in your last answer, leaving out of present

701 consideration your views respecting the *non-integral* or *integral* possible plan of construction, and leaving out of consideration, also, your views as to what *might* be done under the specification of patent 360,070, I understand that your last answer admits that it is a fact that, in complainants' patent 360,070, two valves are brought into action, and each performs its function, to wit, one, which is the auxiliary valve 41, which opens to admit the train-pipe air to the brake-cylinder, and the other, which opens to admit auxiliary reservoir air to the brake-cylinder. Is this admission in your last answer?

A. No, I said nothing of the sort. My remarks were entirely confined to the specific and particular construction given in the drawings of patent 360,070, and further, my remarks, in explanation of my last answer, are necessary to the understanding of that answer, and I cannot accept that they be separated from that answer.

840 X Q. When making a quick-action application of the brakes, of the device shown and described in complainants' patent 360,070, I ask you, do you deny that two valves are brought into action to perform their functions, to wit, one, which is the auxiliary valve 41, which opens to admit train-pipe air to the brake-cylinder, and the

other, a valve which opens to admit auxiliary reservoir air to the brake-cylinder?

A. Yes, so far as described in the specification; as the specification does not say that the auxiliary valve shall not be a part of the main valve. So far as the particular construction shown in the drawings is concerned, I answer, no.

841 X Q. Can you point out, in the specification of complainants' patent 360,070, any statement to the effect that, when making a quick-action application of the brakes, one valve may be employed to admit both the train-pipe air to the brake-cylinder, and also the auxiliary reservoir air to the brake-cylinder, by uncovering a port?

Objected to, as already, in substance, asked and answered.
702 Counsel for defendants suggests that the objection by complainants' counsel is a groundless objection, even if it has been already asked and answered, which counsel for defendants denies.

A. The specification does not *state* that the auxiliary valve shall be integral, or that it shall not be integral, but the specification contains sufficient directions to enable any practical mechanic to make a quick-action triple valve, and the minor details of location and integrality are left, as they always are in general specifications, to the good judgment of the designer.

842 X Q. Your answer to my last question does not respond by pointing out, in the specification of complainants' patent 360,070, any statement to the effect that, when making a quick-action application of the brakes, one valve may be employed to admit both the train-pipe air and also the auxiliary reservoir air to the brake-cylinder, by uncovering a port.

You merely admit that the specification does not state that the auxiliary valve shall be integral or that it shall not be integral, as to which no question was propounded to you whatever. I now repeat X Q. 841, to wit:

"Can you point out in the specification of complainants' patent 360,070 any statement to the effect that when making a quick-action application of the brakes one valve may be employed to admit both the train-pipe air to the brake-cylinder, and also the auxiliary reservoir air to the brake-cylinder by uncovering a port?"

Same objection.

A. Looking at the specification as a direction how to construct a quick-action triple valve, in the light of my long and continued experience with specifications since 1878, I will say that, to me, the specification of patent 360,070 distinctly permits that "one
703 valve *may be* employed to admit both the train-pipe air to the brake-cylinder and also the auxiliary reservoir air to the brake-cylinder."

So far as any "statement" is concerned, I have distinctly answered the question in my preceding answer, and I now repeat that:

"The specification does not say that the auxiliary valve shall not

a part of the main valve," neither does it state it shall be a part
he main valve.

13 X Q. Then I understand that your answer, in part, is that, the light of your long experience, to you the specification of nplainants' patent "*permits*" that "one valve may be employed admit both train-pipe air to the brake-cylinder and also the aux- ry reservoir air to the brake-cylinder."

But you cannot point out in the specification any specific state- ent to that effect? Am I correct?

A. Yes.

844 X Q. In defendants' quick-action valve, plate XI, catalogue 91, are two valves employed to produce a quick-action application the brakes—one which opens to admit only train-pipe air to the ake-cylinder, and another which opens to admit only auxiliary servoir air to the brake-cylinder?

A. Taking the question in a strict literal sense, I answer, no; but, I have explained in a preceding answer, passage B has the office a valve, in restricting the flow and regulating the flow of reser- ir air, and, therefore, in a practical sense, there are two valves.

845 X Q. In defendants' quick-action valve, when producing a ick-action application of the brakes, are there two ports, each of hich is opened by a separate valve, one to admit auxiliary reser- ir air to the brake cylinder, and the other to admit train-pipe air the brake cylinder?

A. Taking the question in a strict literal sense, I answer no; but, I have explained in a preceding answer, two distinct and entirely parate ports are brought into action at the time of quick action, one of which is used "to admit auxiliary reservoir air to the
04 brake-cylinder and the other to admit train-pipe air to the brake cylinder."

846 X Q. In defendants' quick-action valve, when producing a uick-action application of the brakes, is there a port which is un- overed by a valve to admit the passage of train-pipe air to the brake- linder, and another port which is also uncovered by a valve, to dmit auxiliary reservoir air to the brake-cylinder?

A. Taking the question in a strict literal sense, I answer, no; but, s I have explained in a preceding answer, two distinct and entirely parate ports are brought into action, and ports that are used at no her time, for any practical purpose, but have their office solely in ssisting to produce quick action. One of these ports is used "to dmit the passage of train-pipe air to the brake-cylinder" and the ther is used "to admit auxiliary reservoir air to the brake- ylinder."

847 X Q. Please designate the two distinct and separate ports to hich you refer in your last answer.

A. The port uncovered by valve 22 for the admission of train- pipe air to the brake-cylinder, the office of which I have set forth in preceding answer more fully than here, showing that it corresponds o the port 42 of complainants' device.

The port B for the admission and control of auxiliary reservoir ir to the brake-cylinder, the office of which I have set forth in a

preceding answer more fully than here, showing that it corresponds to port 35 of complainants' device.

848 X Q. I understand you to say that the port which admits train-pipe air to the brake-cylinder is uncovered by the valve 22 in the quick-action application of the brakes; now I ask you what valve, if any, uncovers the "port B," which admits auxiliary reservoir air to the brake-cylinder in the quick-action application of the brakes?

A. Port B, like port 35, of complainants' device, is always uncovered to auxiliary reservoir air.

705 The answer is objected to, because it is not responsive. The question does not call for a comparison of "port B" with any other part in complainants' patent.

849 X Q. I will put the question in a slightly different form. In defendants' quick-action valve, is "port B" uncovered by a valve to put it in condition to admit the passage of auxiliary reservoir air to the brake-cylinder, in the quick-action application of the brakes?

A. There is a wide difference between uncovering a port, and simply putting it into condition to be useful; therefore, I will divide my answer into two parts, one with reference to the uncovering, in a strict literal sense, and the other with reference to putting it into condition to be useful, and I will illustrate my answer with suitable examples to make my meaning clear.

Port B is not uncovered by a valve, but, as I have explained before, is always uncovered to auxiliary reservoir air. An example of this is found, in complainants' device, in port 35, which is not uncovered by a valve, but which is always uncovered to auxiliary reservoir air. A further explanation of this will be found in my preceding answers.

Port B is put into condition to admit and control the passage of auxiliary reservoir air to the brake-cylinder, in a quick-action application of the brakes, by the further traverse of the triple-valve piston. An example of this is found in complainants' device, in port 35.

Counsel for defendants objects to all of the answer, except at the beginning of the second paragraph, where the answer states:

"Port B is not uncovered by a valve," for the reason that it is a volunteered argument, not responsive to the question.

706 850 X Q. I understand that, in defendants' quick-action valve, when making a quick-action application of the brakes, no valve is employed to put port B in condition for admitting the passage of auxiliary reservoir air to the brake-cylinder; while in complainants' quick-action valve patent 360,070, when making a quick-action application of the brakes, a valve is employed to put a port in condition for admitting the passage of auxiliary reservoir air to the brake-cylinder. I now ask you, whether or not you agree with my understanding, as I have just stated it.

Objected to as irrelevant and immaterial.

A. I do not.

851 X Q. Please state whether or not, in both the defendants' quick-action valve and in the quick-action valve of complainants' patent, when making a quick-action application of the brakes, a check-valve which, in defendants' is denoted by 26, and, in complainants' patent, is denoted by 49, does not open to admit the passage of train-pipe air to the brake-cylinder?

A. The check-valves mentioned in the question are opened by the train-pipe air itself, but the office and function of the check-valves is to prevent the return of train-pipe air after it has passed to the brake-cylinder. The valves which perform the function of *opening to admit* train-pipe air to the brake-cylinder are the valve 22 of defendants' device, and valve 41 of complainants' device.

852 X Q. Will you please designate both in defendants' and complainants' quick-action valve devices, those valves which admit the auxiliary reservoir air to the brake-cylinder, when producing a quick-action application of the brakes?

A. The function of admitting and controlling the flow of auxiliary reservoir air to the brake-cylinder in quick action is, as I have before explained in detail, fully performed and regulated by the passage B of defendants' valve, and the passage 35 of complainants'
707 valve; and these ports, in restricting and regulating the flow
of auxiliary reservoir air, have, for all practical purposes of useful operation in defendants' and complainants' valves, the function of valves. The difference is this, that port B is fixed, in the structure, in defendants' device, while the port 35 is in the movable slide-valve 14, of complainants' device. Where the auxiliary air goes to, or the passage which it traverses, after passing through the ports 35 and B, is immaterial, provided there is no further regulation, control, or a restriction of it, until it reaches the brake-cylinder. The practical purposes of control are performed by the ports 35 and B.

It is my opinion, that in referring to the parts which admit auxiliary reservoir air to the brake-cylinder, the ports 35 and B should be considered as having the functions of valves, in that they regulate the flow of the fluid, and, to this extent, they may be rightly considered as valves, but only in the sense, as I have just said, that they restrict and control the flow of the fluid. I think the question cannot be answered definitely.

Adjourned to Monday, January 15, 1894, at 10.30 a. m.

New York, *January* 15, 1894—10.30 a. m.

Met pursuant to adjournment.

Present: Counsel as before.

Deposition of D. L. Barnes resumed:

853 X Q. You say, as the closing part of your last answer: "I think the question cannot be answered definitely." Now I ask you to state why you think so?

708 A. Mainly, for the reason that the question adheres to the names of parts, rather than the function of parts, which, as I

have said before, leads to indefiniteness. If the question had been, What parts have the function of admitting "auxiliary reservoir air to the brake-cylinder when producing a quick-action application of the brakes"? then I could have made a definite answer, and would have replied, that the function is performed and absolutely controlled by the passage B of defendants' valve, and the passage 35 of complainants' valve.

To further illustrate the impossibility of a definite answer, I will explain how a passage may be a valve, for all practical purposes of controlling the admission of a fluid, and yet not be correctly termed, a "valve," in the strictest sense, although I think the broad meaning of the term "valve," may, in some cases, be taken rightly to include ports or passages that act as valves.

Passages and ports may be used as ducts, simply for the purpose of conveying a fluid. In such cases, the size of the passage is immaterial, provided it is large enough, but where passages have the function of a valve, in controlling, regulating, and restricting the flow of a fluid, they are made of a definite size, and cannot be larger or smaller, without interfering with the regulation of the function. A case of this kind is found in passage 35 of complainants' valve and B of defendants' valve. These passages are determined by experiment, as to size, and cannot be larger or smaller, without interfering seriously with the quick action of the brakes. The Master Car Builders' Association have proposed requirements which necessitate a very close regulation of the size of the restricted passage leading from the auxiliary reservoir to the brake-cylinder, at the time of quick action, such as passages 35 and B. This emphasizes the fact that these passages control, regulate, and restrict the passage of the fluid, and to that extent, they have the function of valves.

709 Examples of the class of passages that have no necessarily specific size, provided they are large enough, and which simply act as ducts to convey fluid, are the passage 43 of complainants' valve, and the passage uncovered by the valve 22 of defendants' valve.

The question asks, in effect, which valves admit the auxiliary reservoir air to the brake-cylinder when producing quick action. When a valve opens a passage to admit a fluid from a reservoir into said passage, and thence through to a cylinder, it is clear that the passage was previously not opened. This is the case, for instance, with passage 31, when opened by valve 29, but, in the case of passages 35 and B, they were previously open to the fluid from the reservoir, and, strictly speaking, and holding closely to the question they are not opened by valves, but are brought into action to perform their function, upon the further traverse of the triple-valve piston.

I can give a definite answer to the question if the functions of the parts are asked about.

I quote from the Century Dictionary, regarding a valve:

"Any device or appliance used to control the flow of a liquid, vapor, or gas, or loose material in bulk, through a pipe, passageway, outlet, or inlet, in any form of containing vessel."

In forming my opinion of the broadest acceptable use of the term "valve," I have not been confined to dictionary definitions, but have taken into account the use to which the term is put in practical mechanics.

854 X Q. Is it not a fact that, in complainants' quick-action valve device, the "*part*" which puts the auxiliary reservoir air in communication with the brake-cylinder, when producing a quick-action application of the brakes, is *a part which is opened and closed* by the movement of the slide-valve 14?

A. Port 23 is such a part. It is opened and closed by the valve 14, and puts the auxiliary reservoir into communication with the brake-cylinder, but port 23 does not control the admission
710 of air from the auxiliary reservoir to the brake-cylinder during quick action, but acts only as a duct. The control is wholly with the passage 35, corresponding to passage B of defendants' device, as I have before explained.

855 X Q. In defendants' quick-action valve device, please state what "*part*" is opened and closed by the movement of a valve to put the auxiliary reservoir air into communication with the brake-cylinder, when producing a quick-action application of the brakes?

A. First, is opened the passage *i, j, k*, by the movement of the valve 18, to admit auxiliary reservoir air to the brake-cylinder; then follows the opening of the large passage, by the lifting of the valve 22, upon the further traverse of the piston for the admission of train-pipe air to the brake-cylinder, and this passage being enormously larger than the passage *i, j, k*, the air from the auxiliary reservoir follows the line of least resistance, and nearly, if not quite all of it, will then pass through the passage uncovered by valve 22, and only a smaller portion will go through the passage *i, j, k*. The control of the admission of auxiliary reservoir air to the brake-cylinder, during the quick action, is not provided for by the passage *i, j, k*, nor by valve 22, but solely, as I have before explained, by passage B, which is made of a specific size for that purpose.

As I have before explained, it is my opinion that cavity C should be considered as a part of the brake-cylinder cavity, after valve 22 has been lifted from its seat, and the point of admission, control, and regulation and restriction, of auxiliary reservoir air to the brake-cylinder, is the passage B.

856 X Q. In the device of complainants' patent, does not the slide-valve 14, in putting the auxiliary reservoir into communication with the brake-cylinder, when producing a quick-action application of the brakes, perform a triple-valve function?

A. It performs the second function of plain triple valves prior to 1887, in the manner specified in my testimony before this, and to which I now refer.

857 X Q. I am not quite sure whether your answer is re-
711 sponsive to the question which asks whether, *when producing a quick-action application of the brakes*, the slide-valve 14 performs a triple-valve function? Does it perform this function or not?

Objected to as already fully answered.

A. When producing a quick-action application of the brakes, the valve 14 performs the second function of plain triple valves prior to 1887, in the manner specified in my testimony before this, and to which I now refer. However, it must be remembered that I have distinctly testified that the control of this second function, during quick action, is wholly performed by the passage 35.

Counsel for defendants objects to the last part of the answer, commencing with the word "however," as referring to matters not at all called for by the question, and is therefore not responsive.

858 X Q. With the port *i* (40) plugged, how many valves would take part in the performance of the quick-action function in defendants' triple-valve apparatus; I mean, how many valves would take part in the admission of air pressure into the brake-cylinder, exclusive of the valve which closes the exhaust from the brake-cylinder to the atmosphere?

A. This question relates to a hypothetical valve, and further, any answer that I can make to it will necessarily be indefinite, and have no practical meaning, for the reason that, as I have said before, in compound valves, the number of parts is no indication of the number of functions, or the method of performing the number of functions. In making my answer I shall construe the term "valve" broadly, as the question is of itself a broad one, and demands a general answer. I could give a specific answer, if the parts which perform useful functions, during "the performance of the

712 quick-action function in defendants' triple-valve apparatus," were inquired about.

Leaving out of consideration the port *i* (40) and the valve 17, the remaining valves are check-valve 26, opened by train-pipe pressure, valve 22 for the admission of train-pipe air, opened by the further traverse of piston, and the specific passage valve B.

The answer then is, with the limitation given in the question: three valves.

859 X Q. In defendants' quick-action valve, when making a service application of the brakes, will the auxiliary reservoir air pass through the passage B to the brake-cylinder?

A. Yes, but it is not controlled by that passage, as I have explained in my preceding testimony. It was shown by the experiments that I have cited, that, for all the purposes of service application, the passage B might be destroyed by the removal of the ring 9, and the same practical and useful results be obtained.

Counsel for defendants objects to the entire answer, except the first word "yes," as a volunteered statement not called for by the question.

860 X Q. In complainants' quick-action valve, patent 360,070, when making a service application of the brakes, will the auxiliary reservoir air pass through the port 35 to the brake-cylinder?

A. No. I have so testified in a preceding answer.

861 X Q. In defendants' quick-action valve, as exemplified both in the 1889 and 1891 catalogues, when the piston makes its full

stroke, does it not use a valve which opens a port, through which port both train-pipe air and auxiliary reservoir air pass to the brake cylinder?

A. In defendants' quick-action valves, when the piston completes its stroke, the piston opens a port, by lifting valve 22 for the admission of train-pipe air, and, incidentally, the auxiliary reservoir
713 air passes through that port to the brake-cylinder, but it is not in any way controlled by that port, and that port might as well be removed, so far as it is of any practical value in regulating the admission of auxiliary reservoir air. A specific case of this kind is found in defendants' valve, 1889 catalogue, where the port uncovered by the valve 18 has more than sufficient capacity to permit the passage of all of the auxiliary reservoir air that can flow through the port *e*, thus showing, that the port uncovered by valve 22 performs no useful function, with respect to the auxiliary reservoir pressure, but incidentally becomes a duct, through which the auxiliary reservoir air passes to the brake-cylinder. In fact, for all intents and purposes, as I have before explained, the cavity C is practically a part of the brake-cylinder cavity.

As defendants' quick-action valves do not make any practical *use*, with respect to auxiliary reservoir air, of a valve that is opened by the complete stroke of the triple-valve piston, as I have explained, and bearing that explanation in mind, I answer that:

Defendants' quick-action valves do not *use* a valve which is operated by the further traverse of the piston, to open a port through which the auxiliary reservoir air passes to the brake-cylinder during quick action, but there is such a valve operated in said manner, which is *used* for a definite practical purpose, to admit train-pipe air to the brake-cylinder, and which train-pipe air is not admitted or controlled in any other way.

862 X Q. In complainants' patent 360,070, when the *piston makes a preliminary traverse*, is it not the valve 29 which functionates to *admit air from the auxiliary reservoir to the brake-cylinder?*

A. Yes, after valve 14 has been moved.

863 X Q. Does not Defendants' Exhibit Illustrative Cuts *Drawing No. 3*, and the red line thereon, correctly show the course of the auxiliary reservoir air as it passes to the brake-cylinder, when the piston makes a preliminary traverse?

714 A. Yes.

864 X Q. In complainants' patent 360,070, when the *piston makes a preliminary traverse*, does any valve or valve mechanism at that time functionate to *admit air directly from the main air pipe to the brake-cylinder?*

A. I am asked about the "patent 360,070," but I wish to say here that my answers are entirely confined, both in this case and in any preceding, to the specification and drawings of that patent.

No.

865 X Q. In the quick-action triple valve of complainants' patent 360,070 when the *piston makes a preliminary traverse*, does any valve, or valve mechanism, at that time functionate to *admit air directly from the main air pipe to the brake-cylinder?*

A. No; air is admitted from the main air pipe to the brake-cylinder upon the further traverse of the piston, not during the preliminary traverse.

866 X Q. In the quick-action triple valve of complainants' patent 360,070, when the piston "is forced to the extreme limit of its stroke," or, in other words, when the piston makes a complete traverse, to effect the admission of *air directly from the main air pipe to the brake-cylinder*, is it the valve 29 which then functionates to *admit air from the auxiliary reservoir to the brake-cylinder?*

A. Under the specification, valve 29 might perform the function of admitting air from the auxiliary reservoir to the brake-cylinder during quick action, as I have explained in my answer to Q. 690, wherein, and in previous answers, I have described a construction shown by the exhibit "Complainants' Exhibit Westinghouse Modification." In the particular construction shown on the drawings of patent 360,070, which is one of the designs that may be constructed from the specification of that patent, valve 29 does not perform the function of admitting auxiliary reservoir air to the brake-cylinder during quick action.

867 X Q. In the quick-action triple valve of complainants'
715 patent 360,070, when the piston "is forced to the extreme limit of its stroke," or makes a complete traverse to effect the admission of *air directly from the main air pipe to the brake-cylinder*, I ask you what valve, or valve mechanism, at that time functionates to *admit air from the auxiliary reservoir to the brake-cylinder.*

A. As I have distinguished between the different quick-action triple valves that may be constructed under the specification of patent 360,070, it is necessary now for me to inquire to which construction this question refers?

868 X Q. The question of course refers to the quick-action triple valve of that construction shown in the drawings of complainants' patent 360,070. Please answer the question with this understanding?

A. In the particular construction shown in the drawings of patent 360,070, the port 35 controls the admission of air from the auxiliary reservoir to the brake-cylinder during quick action, as I have set forth in detail in a preceding answer.

In so far as port 35 may be considered to be a valve, as I have explained before, it is the valve mechanism which admits the air from the auxiliary reservoir to the brake-cylinder during quick action. Incidentally, the slide-valve 14 is moved, but the control of the admission of air from the auxiliary reservoir to the brake-cylinder at that time, is wholly performed by the port 35.

869 X Q. Does not the Defendants' Exhibit Illustrative Cuts *Drawing No. 7*, and the red and blue lines thereon, correctly show, in the quick-action triple valve of complainants' patent 360,070, the course of the two kinds of air, namely, the auxiliary reservoir air and the train-pipe air, in passing to the brake-cylinder during quick action?

A. With the understanding that the question refers to the specific construction shown in the drawings of patent 360,070, I answer, yes.

870 X Q. Has the quick-action valve shown in the drawings of

Complainants' Patent 360,070, a passage leading from the
716 auxiliary reservoir to the piston chamber, and another passage leading from the piston chamber to the valve chamber—the latter passage being smaller in area than the former?

A. I ask for information as to which chambers are referred to. The names of the chambers are not a sufficiently definite description of the location for me to make an intelligent reply.

871 X Q. I will state the question again. Has the quick-action valve shown in the drawings of complainants' patent 360,070, a passage leading from the auxiliary reservoir to the chamber containing the piston 12, and another passage leading from the said piston chamber 12 to the valve chamber 24—the latter passage being smaller in area than the former?

A. Yes. Auxiliary reservoir air reaches the piston chamber through the passage shown at the left of Fig. 2 of the drawings of patent 360,070, and this is a larger passage than the passage 51, which leads from the piston chamber to the valve chamber 24. These are the differential passages which enable the establishment of differential pressures to operate the triple-valve piston.

872 X Q. Is not the passage 51 to which you refer in your last answer, the feeding-in or charging passage for train-pipe air, when going to the auxiliary reservoir?

A. It is.

873 X Q. Has the quick-action valve shown in the drawings of complainants' patent 360,070, a passage leading from the auxiliary reservoir to the chamber containing piston 12, and another passage, also for auxiliary reservoir air, leading from the piston chamber to the valve chamber—the latter passage being smaller in area than the former?

A. Yes, the same passages that I have described in the preceding answer, that is, so far as I understand the question.
717 If the functions of the passage are described, I can make a more intelligent answer.

874 X Q. In complainants' quick-action valve, of patent 360,070, does the piston perform the function of admitting auxiliary reservoir air and train-pipe air to the brake-cylinder, or do valves which are actuated by the piston perform those functions?

A. As to which is the performing part of the quick-action triple valve, would depend largely upon how one looks at it. The primary actuating part, and I might say the primary "performing" part, is the triple-valve piston.

875 X Q. Is this the best answer you can make to my last question?

A. It is the most concise, and I can explain, in detail, the action and office of all the individual parts of the quick-action triple valve shown in the drawings of patent 360,070, but I have done this before.

It is pretty clear that the performance of all the functions is inaugurated by the movement of the triple-valve piston.

At 4 p. m., at request of defendants' counsel, adjourned to Tuesday, January 16, 1894, at 10.30 a. m.

NEW YORK, *January* 16, 1894—10.30 a. m.

Met pursuant to adjournment.
Present: Counsel as before.

Deposition of D. L. BARNES resumed:

876 X Q. Has the quick-action valve, shown in the drawings of complainants' patent 360,070, a partition between the valve chamber 24 and the chamber containing the piston 12, which partition divides said two chambers in such manner that a higher
718 pressure of auxiliary reservoir air may be produced on one side of the piston than will exist in the valve chamber when the piston has made its full stroke towards the train-pipe?

A. No.

877 X Q. Can any part of the valve structure shown in the drawings of complainants' patent 360,070, be removed, so as, by such removal, to cause the auxiliary valve 41 to functionate as a triple valve by passing auxiliary reservoir air to the brake-cylinder?

A. No, not so far as I can see from the construction shown in the drawings.

878 X Q. Please state whether or not defendants' quick-action valve has a passage from the train-pipe, a passage from the auxiliary reservoir which is smaller or more restricted than said train-pipe passage, and a single valve coacting with both of said passages and controlling communication between them and the brake-cylinder, whereby, when an emergency application of the brakes is desired, the train-pipe air and auxiliary reservoir air, the former at lower pressure than the latter, will both pass to the brake-cylinder through the single valve?

A. No, for the reasons that I have set forth in detail in preceding answers, where I have shown that passage B controls communication between the auxiliary reservoir and the brake-cylinder, at the time of quick action, and for other reasons that I have given in detail.

879 X Q. Please state whether or not the quick-action valve of complainants' patent 360,070 has the two passages and a single valve coacting with both of said passages, all as stated in the last question?

A. The question, as well as the preceding question, relates to the "control" of the air from the auxiliary reservoir, and it is with that in mind that I made the preceding answer, and now answer to this question, no.

880 X Q. Please state whether or not the quick-action valve
719 of complainants' patent 360,070 has a piston actuated in one direction by auxiliary reservoir pressure, and in the opposite direction by train-pipe pressure, and a single slide-valve, controlling the passage of air to the brake-cylinder from both the train-pipe and the auxiliary reservoir for an emergency application of the brakes?

A. Yes; under the specification of the patent, such construction is allowable. The question is not confined to the drawings. An example of such construction I have described in preceding answers

and have shown how such construction is left, by the specification of patent 360,070, together with other non essential details, to the judgment of the designer; such modification of construction not being an essential or characteristic feature of the specification.

881 X Q. Please designate the preceding answers wherein you have described such a construction as that stated in the last question.

A. Answers to Qs. 667, folios 2230 to 2234, 2240 to 2243, 2244 to 2253; 668, folios 2268 and 2269; 670, folio 2284; 672, folios 2280, 2290, 2297, 2298, 2299, 2315, 2316, 2319, 2320, 2323, 2324; 673, folio 2407; 678, folio 2448; 693, folio 2488; 702, folio 2526; 703, folio 2528; 710, folio 2553; 711, folio 2556; 712, folio 2558; 713, folio 2560; 714, folio 2564, and in answers to other questions.

882 X Q. In your answer to X Q. 880 you say:

"Yes; under the specification of the patent, such construction is allowable."

Please to point out where, in the specification of patent 360,070, you find your warrant for that statement?

Objected to as already fully answered.

Counsel for defendants has no knowledge of an answer to this question.

A. In my answers to X Qs. 737, 738, for the reasons given in answers to X Qs. 728, 734 and 736.

720 883 X Q. You have explained, with reference to Mr. Boyden's testimony, your criticism of Mr. Boyden's improper use of the word "*additional*," notwithstanding the fact that the word "*additional*" is in the specification.

Do you wish to be understood as making the same explanation with reference to Mr. Church's use of the word "*additional*," in view of your statement on page 558, folio 2230 (C. R.) where you said:

"I cannot find the term additional used in the specification and description of the patent 360,070."

A. Yes; and this answer must be taken in connection with my answer to X Q. 713, which further explains my answer to Q. 667, which is quoted or referred to in this present question.

884 X Q. Have you ever conducted any tests under your own direction, on railroad trains in practical service, with quick-action triple valves of the form shown in complainants' letters patent 360,070?

A. No.

885 X Q. The court is to understand that all of your testimony has been given, and all the opinions you have expressed, have been without any consideration on your part of the claims of patent 360,070. This is so, is it not?

A. Yes.

886 X Q. The court is also to understand that in giving your testimony and expressing your opinions about patent 360,070 or about defendants' quick-action triple valves, you have not considered any restrictions and limitations that may be in the claims of said patent. This is so, is it not?

A. Yes. DAVID L. BARNES.

Adjourned *sine die.*

727 UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., of Pittsburg, Pennsylvania.

Fluid-pressure Automatic-brake Mechanism.

Specification forming part of Letters Patent No. 360,070, dated March 29, 1887.

Application filed November 19, 1886. Serial No. 219,353. (Model.)

To all whom it may concern:

Be it known that I, George Westinghouse, Jr., residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, a citizen of the United States, have invented or discovered certain new and useful improvements in fluid-pressure automatic-brake mechanism, of which improvements the following is a specification:

The object of my invention is to enable the application of brake-shoes to car-wheels by fluid pressure to be effected with greater rapidity and effectiveness than heretofore, more particularly in trains of considerable length. as well as to economize compressed air in the operation of braking by utilizing in the brake-cylinders the greater portion of the volume of air which in former practice was directly discharged into the atmosphere.

To this end my invention, generally stated, consists in a novel combination of a brake-pipe, an auxiliary reservoir, a brake-cylinder, and a "triple-valve" device governing, primarily, communication between the auxiliary reservoir and the brake cylinder, and, secondarily, communication directly from the brake-pipe to the brake-cylinder.

The improvements claimed are hereinafter fully set forth.

In the application of the Westinghouse automatic brake as heretofore and at present commonly in use, each car is provided with a main air-pipe, an auxiliary reservoir, a brake-cylinder, and a triple valve, the triple valve having three connections—to wit, one to the main air-brake pipe, one to the auxiliary reservoir, and one to the brake-cylinder. The main air-pipe has a stop-cock at or near each of its ends, to be opened or closed as required, and is fitted with flexible connections and couplings for connecting the pipes from car to car of a train, so as to form a continuous line for the transmission of compressed air from a main reservoir supplied by an air-pump on the engine. When the brakes are off or released, but in readiness for action upon the wheels of the train, the air which fills the main reservoir and main air-pipes has a pressure of from sixty-five to seventy-five pounds to the square inch, and by reason of the connections referred to the same pressure is exerted in the casings of the triple valves on both sides of their pistons and in the auxiliary reservoirs connected therewith. At the same time passages called "release-ports" are open from the brake-cylinders to the atmosphere. When it is desired to apply the brakes, air is allowed to escape from

(Model.)

3 Sheets—Sheet 1.

G. WESTINGHOUSE, Jr.

FLUID PRESSURE AUTOMATIC BRAKE MECHANISM.

No. 360,070. Patented Mar. 29, 1887.

Nos. 403 & 426
Westinghouse Co
v.
Boyden Co
p 722

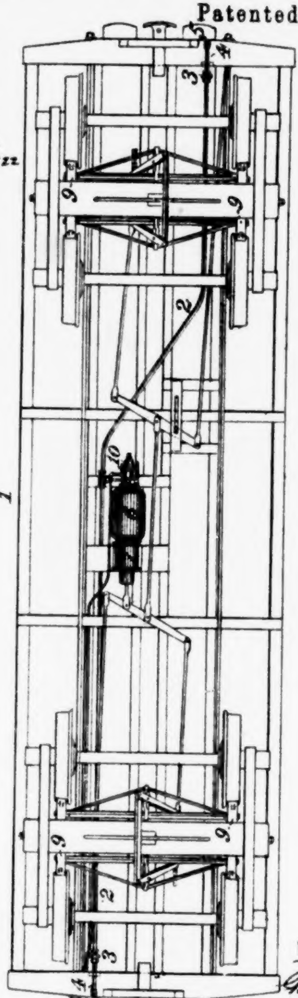


Fig. 1.

Witnesses
R. H. Whittlesey
C. M. Clarke

Inventor
George Westinghouse Jr
By Attorney
J. Snowden Bell

(Model.)

3 Sheets—Sheet 2.

G. WESTINGHOUSE, Jr.

FLUID PRESSURE AUTOMATIC BRAKE MECHANISM.

No. 360,070. Patented Mar. 29, 1887.

Nos. 403 & 426.
Westinghouse Co v. Boyden Co. p 724

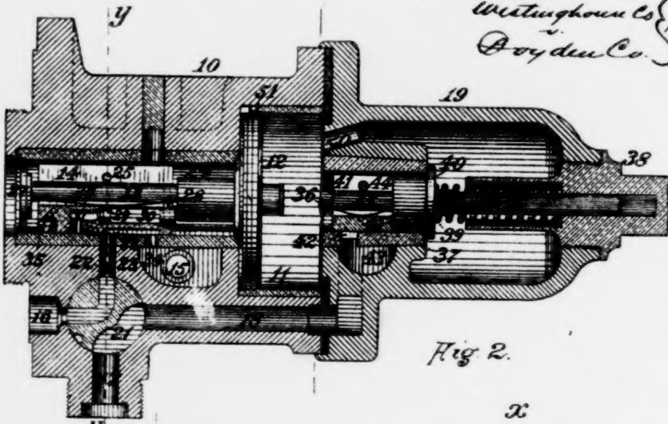


Fig. 2.

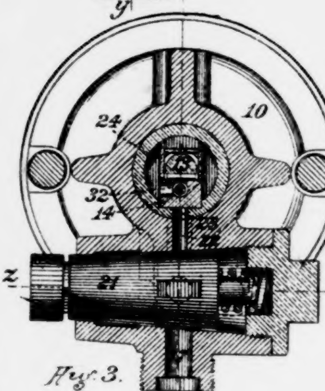


Fig. 3.

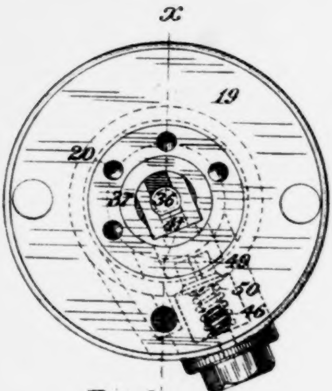


Fig. 4.

Witnesses
R. H. Whittlesey
C. M. Clarke

Inventor George Westinghouse Jr
By Attorney J. Snowden Bell

7794

(Model.)

3 Sheets—Sheet 3.

G. WESTINGHOUSE, Jr.

FLUID PRESSURE AUTOMATIC BRAKE MECHANISM.

No. 360,070. Patented Mar. 29, 1887.

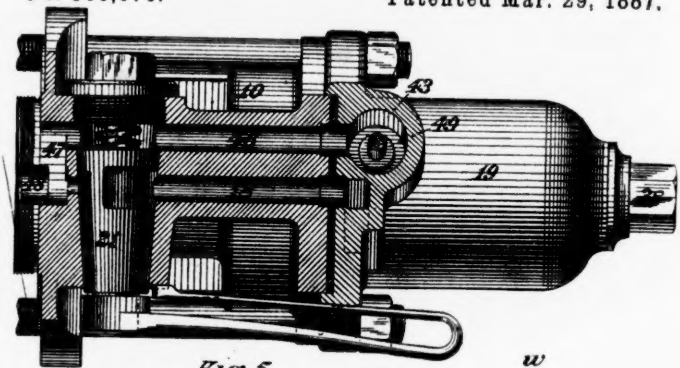


Fig. 5.

Nos. 403 & 426
Westinghouse Co.
v.
Boyden Co.
p 726

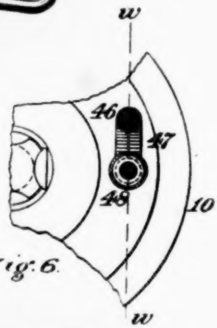


Fig. 6.

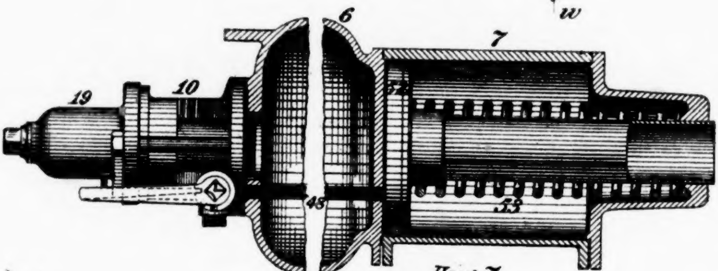


Fig. 7.

Witnesses
R. H. Whittlesey
C. M. Clarke

Inventor George Westinghouse Jr.
By Attorney J. Snowden Bell.

the main air-pipes through the engineer's valve, thereby reducing the pressure in the main air-pipes, whereupon the then higher pressure in the auxiliary reservoirs moves the pistons of the triple valves, so as to first close the passages from the triple valves to the brake-pipe and at the same time close the release-ports of all the brake-cylinders, and then open the passages from the auxiliary reservoirs to the brake-cylinders, the pistons of which are forced out by the compressed air thereby admitted to the brake-cylinders, applying the brakes by means of suitable levers and connections, all of which mechanism is fully shown in various letters patent granted to me.

The application of the brakes with their full force has heretofore required a discharge of air from the main pipe sufficient to reduce the pressure in said pipe below that remaining in the auxiliary reservoir after the brakes have been fully applied, and it has been found that, while the brakes are sufficiently quick in action on comparatively short trains, their action on long trains of from thirty to fifty cars, which are common in freight service under present practice, is in a measure slow, particularly by reason of the fact that all the air required to be discharged from the main pipe to set the brakes must travel from the rear of the train to a single discharge-opening on the engine. This discharge of air at the engine has not only involved a serious loss of time in braking, but also a waste of air. Under my present invention a quicker and more efficient action of the brakes is obtained, and air which has been heretofore wasted in the application of the brakes is almost wholly utilized to act upon the brake-pistons.

In the accompanying drawings—

(Here follow diagrams marked pp. 722, 724, & 726.)

Figure 1 is an inverted plan view of a railroad-car, illustrating the application of my invention; Fig. 2, a longitudinal section, on an enlarged scale, through the triple valve at the line *x x* of Fig. 4; Fig. 3, a transverse section through the same at the line *y y* of Fig. 2; Fig. 4, a bottom plan view of the cap or drain-cup of the
728 triple valve; Fig. 5, a longitudinal section through the triple valve at the lines *z z* of Fig. 3 and *w w* of Fig. 6; Fig. 6, a partial bottom plan view of the triple valve; and Fig. 7, a longitudinal central section through the brake-cylinder and auxiliary reservoir, with the triple valve in elevation.

In the practice of my invention each railroad car 1 on which it is applied is, as heretofore, provided with a main air-pipe, 2, governed by stop-cocks 3, adjacent to its ends, and having a flexible connection, 4, and coupling 5 at each end, to admit of being coupled to the main air-pipe of the tender or the adjacent car or cars of a train. An auxiliary reservoir, 6, and brake-cylinder 7 are secured in convenient position below the sills of the car, the brake-cylinder having a piston, 52, by the movement of which, through a system of lever-connections, which do not form part of my present invention, the brake-shoes 9 are applied to and released from the wheels of the car, compressed air being supplied to and released from the brake-

cylinder 7 as the pressure in the main air-pipe is reduced or reinstated, respectively, by means of a triple valve, 10, the casing or chest of which communicates with the main air-pipe, the auxiliary reservoir, and the brake-cylinder.

So far as the performance of its preliminary function in ordinary braking is concerned—that is to say, effecting the closure of communication between the main air-pipe and the auxiliary reservoir, and the opening of communication between the auxiliary reservoir and the brake-cylinder in applying the brakes, and the reverse operations in releasing the brakes—the triple valve 10 accords substantially with that set forth in letters patent of the United States No. 220,556, granted and issued to me October 14, 1879, and is not, therefore, saving as to the structural features by which it performs the further function of effecting the direct admission of air from the main air-pipe to the brake-cylinder, as presently to be described, claimed as of my present invention. Certain of its elements devised and employed by me prior thereto will, however, be herein specified, in order to render its construction and operative relation to other members of the brake mechanism fully intelligible.

The case or chest in which the operative mechanism of the triple valve proper, 10, is mounted is fixed under or on the car-body in any convenient position relatively to the auxiliary reservoir 6 and brake-cylinder 7, being in this instance shown as secured directly to one end of the auxiliary reservoir, in line axially therewith and with the brake-cylinder, which is secured to its opposite end. The triple-valve case is fitted at one end with a cylindrical sleeve or bushing, 11, which is bored out truly and forms the chamber of a piston, 12, which is fixed upon a stem, 13, carrying, as in my letters patent No. 220,556, before mentioned, a slide-valve, 14, which controls communication between the auxiliary reservoir and the brake-cylinder, and between the brake-cylinder and release-port 15, respectively. The auxiliary reservoir 6 is continuously in communication with the chamber 11, on one side of the piston 12, through the longitudinal chamber 24 of the case in which the slide-valve 14 moves, and the triple-valve case communicates, by a passage, 16, with the brake-cylinder, and, by a passage, 17, with the main air-pipe 2. The passage 17, leading from the main air-pipe, communicates, by a passage, 18, with the cap or, as it is ordinarily termed, the "drain-cup" 19 of the triple valve, from which passages 20 lead into the piston-chamber 11. A four-way cock, 21, controls the passages 16, 17, 18, and a passage. 22, leading to a port, 23, in the face or seat of the slide-valve 14. When in the position shown in the drawings, communication is continuously maintained between the main air-pipe 2 and piston-chamber 11, through the passages 17 and 18, drain-cup 19, and passages 20, and by turning the cock 21, so as to establish communication between the passages 16 and 17, the triple valve and auxiliary reservoir will be cut out from the main air-pipe, and the mechanism can be operated as a non-automatic brake, the admission of air under pressure to the main air-pipe and brake-cylinder effecting, in such case, the application of the brakes.

The entire brake mechanism of the car other than the main air-pipe may be put out of action, when for any reason required, by turning the cock 21 into position to cover the passages 16 and 18, the main air-pipe then serving only for the transmission of air between the portions of the train-line made up by the main air-pipes of the remaining vehicles.

The slide-valve 14 is loosely connected with the stem 13 of the piston 12, and by a pin, 25, extending across the stem and fixed in the side plates of the valve, is prevented from being separated from the stem when removed for examination. It is held up to its seat in the chamber 24 by a spring, 26. The valve partakes in the reciprocating movements of the stem 13, being moved in one or the other direction by a collar, 27, and a shoulder, 28, respectively, on the stem. Said collar and shoulder are located at a distance apart slightly greater than the length of the valve 14, so that a limited degree of traverse of the stem 13 and piston 12 in each direction is effected without imparting movement to the valve. A graduating-valve, 29, secured upon a stem, 30, which is moved by the piston-stem, 13, governs a passage, 31, in the slide-valve 14, said passage communicating by a lateral port, 32, with the valve-chamber 24, and consequently with the auxiliary reservoir. A cavity or passage, 33, is formed on the face of the slide-valve 14, of such length as to establish communication during a portion of the traverse of
729 the valve between the port 23 of the valve-chamber 24, which
is open to the passage 16, leading to the brake-cylinder, and a port, 34, communicating with the relief-port 15.

The construction and relative arrangement of the piston-stem 13, slide-valve 14, and graduating-valve 29 are substantially similar to those of the corresponding parts as heretofore employed by me and exemplified in my letters patent No. 220,556; but under my present invention these are supplemented by a port, 35, leading from the end of the valve adjacent to the opening of the chamber 24, which communicates with the auxiliary reservoir, to the face of the valve, so as, at the limit of traverse of the piston-stem in the application of the brakes, to establish communication directly through said passage between the auxiliary reservoir and the port 23 and passages 22 and 16, leading to the brake-cylinder.

The piston-stem 13 abuts when the stem 13 and piston 12 are moved for the major portion of their traverse toward the drain-cup 19 against a stem, 36, which is fitted to slide freely in line axially with the stem 13 in an open-ended bushing, 37, in the end of the drain-cup 19 adjoining the piston-chamber 11, and in a guide formed in a screw-cap, 38, closing the opposite end of the drain-cup. A spring, 39, surrounding the stem 36 and bearing against the inside of the cap 38 and against a collar, 40, on the stem 36, maintains the latter in the position shown in Fig. 2, except when a sufficient pressure of air is admitted from the auxiliary reservoir to the piston-chamber to overcome the resistance of the spring and effect movement of the piston 12 beyond the point at which its stem 13 comes in contact with the stem 36.

So far as hereinbefore described, the triple valve accords in all

substantial particulars with and is adapted to operate similarly to those of my letters patent Nos. 168,359, 172,064, and 220,556, and, in order that it may perform the further functions requisite in the practice of my present invention, it is provided with certain additional members, which will now be described. For the purpose of effecting the admission of air directly from the main air-pipe 2 to the brake-cylinder 7 when it is desired to apply the brakes with great rapidity and full force, an auxiliary slide-valve, 41, is connected to and moves with the stem 36, said valve working over a face in the bushing 37 between the piston-chamber 11 and drain-cup 19, and governing a port, 42, in said face leading into a chamber, 43, adjoining the same. The valve 41 has lateral wings or plates fitting on each side of the stem 36, between shoulders or collars thereon, and is held thereto, when the stem is removed, between collars or shoulders thereon abutting against its ends, by a pin, 44, in its wings, a spring, 45, acting to hold it to its seat in the bushing 37 when in position. The chamber 43 communicates by a passage, 46, Fig. 5, with a chamber, 47, in the end of the case of the triple valve adjacent to the auxiliary reservoir, from which chamber a passage, 48, leads through the auxiliary reservoir into the brake-cylinder 7. The chamber 43 is further provided with a check-valve, 49, which opens outwardly into and controls the passage of air into the passage 46, said valve being held to its seat by a light spring, 50, and serving to prevent the return of air from the brake-cylinder when the pressure in the main air-pipe is reduced below that in the brake-cylinder, as in the case of the separation of the cars of the train by the breaking of a coupling.

In the operation of the brake mechanism as above described, air from the main reservoir and main air-pipe passes through the passages 17 18, drain-cup 19, and passages 20 into the piston-chamber 11, forcing the piston 12 to the left-hand extremity of its stroke and uncovering a small feeding-groove, 51, in the piston-chamber, through which air passes into the auxiliary reservoir 6 until the pressure in the latter is equal to that in the main air-pipe, the brake-cylinder being meanwhile in communication with the atmosphere through the passages 16 and 22, valve-cavity 33, and ports 23 34, and release-port 15. To apply the brakes in making ordinary stops, a portion of the air is discharged from the main air-pipe by the engineer's valve, thereby correspondingly reducing the pressure in the main air-pipe, whereupon the higher pressure in the auxiliary reservoir moves the piston 12 to the right, covering the feeding-groove 51, and thus preventing the return of air from the auxiliary reservoir to the main air-pipe, the movement of the piston continuing until arrested by the decrease of pressure in the auxiliary reservoir or by the stem 36 and its spring 39. The movement of the slide-valve 14 then closes the port 23, preventing escape of air from the brake-cylinder, and places the passage 31 partly or wholly in communication with the port 33. The small auxiliary valve 29 having been meanwhile unseated by the movement of the piston-stem, compressed air from the auxiliary reservoir passes through the lateral port 32 and passage 31 of the slide-valve 14 and the passages 22 and 16 of the triple-valve case to the brake-cylinder,

rcing out the piston, and, through an appropriate system of vers and connections, applying the brakes. When the pressure 1 the auxiliary reservoir has in this operation been reduced by xpansion into the brake-cylinder until it is slightly below the ressure in the main air-pipe, the pressure on the air-pipe side of ne piston 12 forces the piston 12 in the opposite direction until the uxiliary valve 29 closes the passage 31, thereby arresting the furner flow of air from the reservoir to the brake-cylinder and holding ne brakes with a force proportionate to the reduction of pressure 1 the brake-pipe. To release the brakes, the pressure in the main ir-pipe is increased by admitting air from the main reservoir, vhereupon the resultant increase of pressure in the piston-chamber 11 forces the piston 12 back to its original or normal position, permitting the escape of air from the brake-cylinder 7, the piston 52 of which is returned to its position by a spring, 53, eleasing in its backward movement the brake-shoes 9 from the vheels, and at the same time the auxiliary reservoir is recharged. The admission of air to the brake-cylinder through the passage 31, vhich is opened just before the piston-stem comes in contact with the graduating-stem, and which corresponds to the feed-passage heretofore employed, suffices for the ordinary requirements of braking n regular service. In the event, however, of its becoming necessary o apply the brakes with great rapidity and with their greatest available force, the engineer, by means of the valve at his command, nstantly discharges sufficient air from the front end of the main air-pipe to effect a sudden reduction of pressure of about twenty pounds per square inch therein, whereupon the piston 12 of the triple valve is forced to the extreme limit of its stroke in the direction of the drain-cup 19, carrying with it the stem 36 and auxiliary slide-valve 41, which instantly uncovers the port 42 and discharges air from the main air-pipe through the opening of the check-valve 49 and the passages 46 and 48 to the brake-cylinder, and, each car being provided with one of these devices, it will be seen that they are successively moved with great rapidity, there being practically on a train of fifty cars fifty openings for discharging compressed air from the main pipe, instead of the single opening heretofore commonly used. Not only is there a passage of considerable size opened from the brake-pipe on each car, whereby the pressure is more quickly reduced, but the air so discharged is utilized in the performance of preliminary work, it being found in practice that the air so taken from the pipe will exert a pressure of about twenty-five pounds in the brake-cylinders. When the piston 12 arrives at the extremity of its stroke, as above specified, the supplemental port 35 of the slide-valve 14 is brought into communication with the port 33 and passages 22 and 16, which serves to discharge the reservoir-pressure into the brake-cylinder, thereby augmenting the pressure already exerted in the brake-cylinder by the air admitted from the main air-pipe. Upon the reduction of the pressure in the main air-pipe below that in the brake-cylinders, as by the breaking in two of the train, the check valve 49 closes communication between the passages 46 and 18, thereby preventing the return of the air from the brake-cylinder to the main air-pipe. The feed-opening for

the admission of air from the auxiliary reservoir to the brake-cylinder is purposely made of comparatively small diameter, it having been determined by experiment that the initial application of the brakes should not be made with maximum force, and this opening may be made of such size as to apply the brakes exactly in accord with the requirements of the most efficient work.

In using the terms "triple valve" and "triple-valve device" I refer to a valve device, however specifically constructed, having a connection with the main air or brake pipe, another with an auxiliary reservoir or chamber for the storage of power, and another with a brake-cylinder or its equivalent for the utilization of the stored power and with a release or discharge passage for releasing the operative power from the brake-cylinder, whether the valves governing these passages or connections are arranged in one or more cases and are moved by a piston or its equivalent or by a series of pistons or their equivalents, there being numerous examples in the art of constructions varying materially in appearance whereby these functions are performed, both in plenum and vacuum brake mechanisms.

While I have herein described my invention as applied in a brake mechanism utilizing air under pressure, such as is in general and approved use, I do not desire to limit myself to brakes so operated, as my improvements are likewise susceptible of application, without variation of principle, in connection with brakes worked by atmospheric pressure.

I am aware that a construction in which "an always-open one-way passage" from the main air-pipe to the brake-cylinder is uncovered by the piston of the triple valve simultaneously with the opening of the passage from the auxiliary reservoir to the brake-cylinder has been heretofore proposed, and such construction, which involves an operation different from that of my invention, I therefore hereby disclaim.

I claim as my invention and desire to secure by letters patent—

1. In a brake mechanism, the combination of a main air-pipe, an auxiliary reservoir, a brake-cylinder, a triple valve, and an auxiliary-valve device, actuated by the piston of the triple valve and independent of the main valve thereof, for admitting air in the application of the brake directly from the main air-pipe to the brake-cylinder, substantially as set forth.

2. In a brake mechanism, the combination of a main air-pipe, an auxiliary reservoir, a brake-cylinder, and a triple valve having a piston whose preliminary traverse admits air from the auxiliary reservoir to the brake-cylinder, and which by a further traverse admits air directly from the main air-pipe to the brake-cylinder, substantially as set forth.

3. In a brake mechanism, the combination of a main air-pipe, an auxiliary reservoir, a brake-cylinder, and a triple valve having a piston whose preliminary traverse admits air from the auxiliary reservoir to the brake-cylinder, and which by a further traverse admits air directly from the main air-pipe to the brake-cylinder and effects a second admission of air from the auxiliary reservoir to the brake-cylinder, substantially as set forth.

4. The combination, in a triple-valve device, of a case or

731 chest, a piston fixed upon a stem and working in a chamber therein, a valve moving with the piston-stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere, respectively, and an auxiliary valve actuated by the piston-stem and controlling communication between passages leading to connections with a main air-pipe and with the brake-cylinder, respectively, substantially as set forth.

5. The combination, in a triple-valve device, of a case or chest, a piston fixed upon a stem and working in a chamber therein, a valve moving with the piston-stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere, respectively, an auxiliary valve, actuated by the piston-stem and controlling communication between passages leading to connections with a main air-pipe and with the brake-cylinder, respectively, and a check or non-return valve interposed between the auxiliary valve and the passage leading therefrom to the brake-cylinder, substantially as set forth.

6. The combination, in a triple-valve device, of a case or chest, a piston fixed upon a stem and working in a chamber therein, a valve moving with the piston-stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere, respectively, an auxiliary stem mounted in the cap of the case in position to be moved longitudinally by the piston-stem in the latter portion of its traverse in the direction required for the application of the brakes, a spring bearing against a collar on the auxiliary stem and against a fixed abutment, and an auxiliary valve connected to the auxiliary stem and controlling communication between passages leading to connections with a main air-pipe and with the brake-cylinder, respectively, substantially as set forth.

7. The combination, in a triple-valve device, of a case or chest, a piston fixed upon a stem and working in a chamber therein, an auxiliary valve actuated by the piston-stem and controlling communication between passages leading to connections with a main air-pipe and with a brake-cylinder, respectively, and a main valve connected to the piston-stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere, respectively, said main valve having a supplemental port or passage which establishes communication between the auxiliary reservoir and brake-cylinder connections at or near the limit of the traverse of the main valve in effecting the application of the brake under maximum pressure, substantially as set forth.

In testimony whereof I have hereunto set my hand.

GEO. WESTINGHOUSE, JR.

Witnesses:

J. SNOWDEN BELL.
R. H. WHITTLESEY.

732 (Here follow drawings and diagrams marked pp. 733 to 755, incl.)

759 UNITED STATES PATENT OFFICE.

CHARLES H. PERKINS, of Bloomington, Illinois, assignor to Georg Westinghouse, Jr., of Pittsburg, Pennsylvania.

Improvement in Valves for Air-brakes.

Specification forming part of Letters Patent No. 163,242, dated Ma 11, 1875; application filed March 13, 1875.

To all whom it may concern:

Be it known that I, C. H. Perkins, of Bloomington, in the count of McLean and in the State of Illinois, have invented certain ne and useful improvements in valves for air-brakes; and do hereb declare that the following is a full, clear, and exact descriptio thereof, reference being had to the accompanying drawings mak ing a part of this specification, in which—

(Here follows diagram marked p. 758.)

Figure 1 is a central longitudinal section of my improved a paratus, showing the relative position of parts before air-pressure applied. Fig. 2 is a like view of the same after pressure is applie and while the operative parts are in a state of equilibrium, and Fi 3 shows the position of said operative parts after such equilibriu has been destroyed and air is passing to the brake-cylinder.

Letters of like name and kind refer to like parts in each of th figures.

The design of my invention is to render more simple and efficie the means employed for controlling the admission of air to th cylinder of pneumatic car-brakes; to which end it consists, princ pally, in the combination of the piston-valve with the cylindric valve-box, having its inlet, outlet, and exhaust ports relatively a ranged in the manner and for the purpose substantially as is her inafter specified.

It consists, further, in combining, with one end of said mai valve, a spiral spring, for pressing it toward one end of the valv box, when not otherwise adjusted, by air-pressure, substantially and for the purpose hereinafter set forth.

In the annexed drawings, A represents the box or casing of m valve, constructed in the form of a hollow cylinder, and having i ends closed by means of removable heads B and B′. Upon th upper side of the cylinder A is formed a second supplemental cyli der, C, which corresponds in length to the same, and has about on fourth its diameter. One end of said upper cylinder C is perm nently closed, while its opposite end is closed by means of removable screw-plug, D. Small ports E and E′ are provide between the ends of the cylinders A and C, an opening, F, is form at the upper side and longitudinal center of the latter, while thr openings, G, H, and I, respectively, are provided within the low

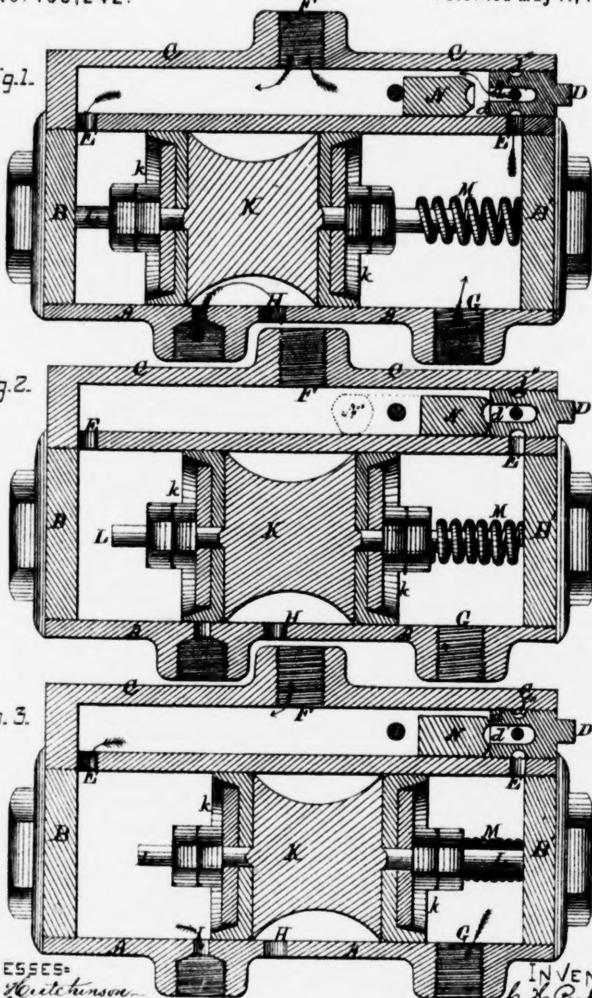
Nos. 403 & 426
Westinghouse Co } h. 758
v
Boyden Co.

C. H. PERKINS.

Valve for Air-Brakes.

No. 163,242. Patented May 11, 1875.

Fig.1.
Fig.2.
Fig.3.



WITNESSES:
Jas. Hutchinson
John R. Young

INVENTOR
C. H. Perkins
by Prindle and Co. his attys

side of said main cylinder A, as shown, the first of said openings G being located near one end, the second opening H at a point just beyond the longitudinal center of said cylinder, while the third opening I is located at a point about one-third of the length of said cylinder from its opposite end. Within the cylinder A is placed a piston-valve, K, which has the form shown; is packed with leather *k* at each end; and is provided with a central rod, L, which extends outward from either end, and, by contact with the heads B and B′, limits the travel of said valve. A spiral spring, M, placed around one end of said rod L, bears against the head B and the end of said valve, and presses the latter to the center, longitudinally of said cylinder, as seen in Fig. 2. Upon the inner end of the plug D, which extends inward beyond the port E, is formed a seat, *d*, which, at its center, is provided with an opening, *d′*, that extends longitudinally into said plug, and then radially outward into a concentric cavity, *d″*, that is formed by grooving said plug. The space *d″* is directly over the port E, so that air passing from the cylinder A through said port can, by means of said space and the opening *d′*, enter the valve-box C. A valve, N, is fitted within the box C, and allowed such longitudinal motion therein as to enable the opening *d′* to be uncovered, as seen in Fig. 1; or, by the seating of said valve, to be closed, as shown by Fig. 2 and 3.

The device is now complete, and being placed beneath a car with the opening G in communication with the air-supply pipe, the opening F in communication with the air-tank, and the opening I in communication with the brake-cylinder, operates as follows: The normal position of parts is, as shown in Fig. 1, the main valve K being thrown beyond the center of its casing A, so as to connect the parts I and H and permit air to escape from the brake-cylinder, which position remains unchanged as air from the pump is admitted through the opening G into said casing, and from the same passes through the port E and passage *d′* into the valve-box C, from
760 the latter through the opening F into the tanks, and through the port E′ into the opposite end of the main valve-box, the pressure of air upon opposite ends of said valve K being just equal. When it is desired to apply the brake, the pressure within the supply-pipe and front end of the valve-box A is decreased, when the pressure within the opposite end of the latter will move the valve K to the position shown in Fig. 3, so as to uncover the outlet-port I and permit air to pass into the brake-cylinder. When the quantity of air passing into the brake-cylinder has been sufficient to cause the pressure within the rear end of the valve-box A and the tank to nearly equal the pressure within the opposite end of said valve-box, the spring M will force the valve K to the central position shown in Fig. 2, and cover the outlet-port I, so as to prevent the escape of air from the brake-cylinder, and cause the pressure of the brake upon the wheels to be maintained. While the brake is on, and the main valve occupies the position shown in Fig. 2, the pressure within the tank may be gradually increased. If it is desired to apply more power to the brake, the pressure within the supply-pipe is again decreased, when the main valve will be again

forced to the position shown in Fig. 3, and air admitted to the brake-cylinder until the pressure upon opposite ends of said valve is equalized as before. To let off the brakes, air-pressure is again applied to the supply-pipe, and through the same to the front end of the main valve-box A, and, when such pressure equals that within the opposite end of the latter, the spring M will force the main valve K in the opposite direction, the port I will be cut off from communication with the air-tank and placed in communication with the exhaust-port H, when the air within the brake-cylinder will escape.

The device described is simple in construction, certain and efficient in operation, and enables the desired work to be performed by use of a smaller number of parts than are usually employed.

Having thus fully set forth the nature and merits of my invention, what I claim as new is—

1. In combination with the valve-box A, provided with the inlet-port G, outlet-port I, and exhaust-port H, and connected through suitable mechanism with an air-pressure tank, the valve K, arranged to move longitudinally within said valve-box, having greater width of bearing than, and capable of covering and uncovering, said outlet-port I, and of connecting the same with said exhaust-port H, substantially as and for the purpose specified.

2. In combination with the valve-box A and valve K, the spring M, placed between one end of said valve-box and said valve, and having such length as to cause said valve to cover the outlet-port whenever the air-pressure upon its ends is equal, substantially as and for the purpose shown.

In testimony that I claim the foregoing I have hereunto set my hand this 8th day of March, 1875.

CHARLES H. PERKINS.

Witnesses:

I. E. EASTMAN.

FRANK. WHITE.

761 "COMPLAINANTS' EXHIBIT BRITISH PATENT 3000 OF 1879."

A. D. 1879, 23d July. No. 3000.

Brakes.

Letters patent to Edward Dunning Barker, of 45 Bedford row, in the county of Middlesex, for the invention of "improvements in automatic brakes worked by fluid pressure."

Sealed the 20th January, 1880, and dated the 23rd July, 1879.

Provisional specification left by the said Edward Dunning Barker at the office of the commissioners of patents on the 23rd July, 1879.

EDWARD DUNNING BARKER, of 45 Bedford row, in the county of Middlesex.

"Improvements in Automatic Brakes Worked by Fluid Pressure."

The object of this invention is to enable brakes that are automatic in their action (or which are self-applied if the train becomes disconnected) to be used effectually in the ordinary working of trains. For this purpose it is requisite that the brakes should be capable of being applied with greater or less force, and that provision should be made for increasing or diminishing this force at the pleasure of the engine driver or operator.

In the automatic brakes at present in use, air or other fluid is stored under pressure in reservoirs upon the carriages, and when the brakes have to be applied, the fluid is allowed to pass from the reservoirs into the brake-cylinders; valves being then permitted to open by the reduction of the pressure in a main pipe laid along the train. There is a small piston in connection with each valve, and when the piston is thus relieved from pressure on one side it yields to a counter-pressure on the other side, thereby moving the valve and permitting the fluid to flow from the reservoir to the
762 cylinder. When the pressure in the main pipe is restored the piston operates to close the communication between the reservoir and the brake-cylinder, and to open a passage for the escape of the air or fluid from the brake cylinder.

Now in such automatic brakes, in order that the amount of pressure upon the brake may be completely under control, I employ a regulating cylinder in communication with the brake-cylinder, and containing another piston also connected with the admission and exhaust valve of the brake-cylinder. When there is pressure within the brake-cylinder this pressure operating on the piston in the regulating cylinder acts in conjunction with the pressure in the main pipe to hold the valve closed to the passage of fluid from the reservoir to the brake-cylinder, and open for the escape of fluid

from the brake-cylinder. With this arrangement a reduction of pressure in the main pipe first causes the valve to open as usual for the passage of air or fluid from the reservoir into the brake-cylinder, but this only continues until the pressure in the brake-cylinder is such that acting in the regulating cylinder in aid of the pressure on the valve piston, the two together suffice to close the valve again against the passage of fluid from the reservoir to the brake-cylinder.

Thus the pressure in the brake-cylinder is at all times dependent on the pressure in the main pipe, and whatever may be the pressure in the brake-cylinder at any time a slight increase in the pressure in the main pipe (which is under the direct control of the engine driver or operator) causes a corresponding diminution of the pressure in the brake-cylinder; and a decrease in the pressure in the main pipe causes a corresponding increase of pressure in the regulating cylinder and in the brake cylinder.

Regulating cylinders may be applied in the manner I have described to the existing valves of automatic brakes, but I prefer the following arrangement: I employ two pistons of different sizes formed in one piece or fixed on the same rod; these pistons are received into a cylinder bored to two diameters to fit the pistons. The main pipe communicates with the end of the cylinder in which the smaller piston works. There is also an aperture
763 in this part of the cylinder by which the air or fluid can pass from the cylinder past a check-valve (which prevents return) into a valve box on the side of the cylinder, and from this valve box by a pipe to the reservoir. The valve box contains a slide-valve working over *over* two ports, one being an opening into the centre part of the cylinder or to the space between the two pistons, which space is always in communication with the brake-cylinder; and the other being an outlet passage by which the fluid is allowed to escape from the brake-cylinder when it is necessary to reduce the pressure upon the brake-blocks. The valve moves with the pistons with which it is connected by a stud or projection passing through the first-mentioned port or passage. A coiled spring abuts upon the larger piston, tending to force the pistons to the end of the cylinder, at which the air or fluid under pressure enters it from the main pipe. When the fluid in the main pipe is at the full working pressure the spring is overcome and the pistons are pressed back; the valve is thus placed in such a position that the centre space between the pistons is in communication with the exhaust passage, so that no pressure is retained either here or in the brake-cylinder. Hence at this time the brakes are off, and the reservoir is charged under pressure. When a reduction is made in the pressure in the main pipe the pistons move under the influence of the spring carrying the valve with them, thereby closing the exhaust passage and opening the port by which fluid enters between the pistons; the passage of fluid from the reservoir to the brake-cylinder is thus permitted. As the pressure accumulates between the pistons however it acts on the piston of the larger area in such manner as to aid in compressing the spring, and when a sufficient compensation is thus

obtained for the reduction of pressure which has been made in the main pipe the pistons return carrying back the valve, so that no further rise of pressure in the brake-cylinder can take place until a further reduction of pressure is made in the main pipe. On the other hand when the pressure in the main pipe is increased the pistons and valve move in the contrary direction; and fluid is permitted to escape from the brake-cylinders, reducing the pressure therein or relieving it entirely so as to take off the brakes

764 Specification in pursuance of the conditions of the letters patent filed by the said Edward Dunning Barker in the Great Seal patent office on the 23d January, 1880.

EDWARD DUNNING BARKER, of 45 Bedford row, in the county of Middlesex.

"Improvements in Automatic Brakes Worked by Fluid Pressure."

The object of this invention is to enable brakes that are automatic in their action (or which are self-applied if the train becomes disconnected) to be used effectually in the ordinary working of trains.

For this purpose it is requisite that the brakes should be capable of being applied with greater or less force, and that provision should be made for increasing or diminishing this force at the pleasure of the engine driver or operator.

In the automatic brakes at present in use air or other fluid is stored under pressure in reservoirs upon the carriages, and when the brakes have to be applied the fluid is allowed to pass from the reservoirs into the brake-cylinders, valves being then permitted to open by the reduction of the pressure in a main pipe laid along the train. There is a small piston in connection with each valve, and when the piston is thus relieved from pressure on one side it yields to a counter-pressure on the other side, thereby moving the valve and permitting the fluid to flow from the reservoir to the brake-cylinder. When the pressure in the main pipe is restored the piston operates to close the communication between the reservoir and the brake-cylinder, and to open a passage for the escape of the air or fluid from the brake-cylinder.

Now in such automatic brakes in order that the amount of pressure upon the brakes may be completely under control, I employ a regulating cylinder in communication with the brake-cylinder, and containing another piston also connected with the admission and exhaust valve of the brake-cylinder. When there is pressure within the brake-cylinder, this pressure operating on the piston in the regulating cylinder acts in conjunction with the pressure in the main pipe to hold the valve closed to the passage of fluid from the reservoir to the brake-cylinder, and open for the escape of
767 fluid from the brake-cylinder. With this arrangement a reduction of pressure in the main pipe first causes the valve to open as usual for the passage of air or fluid from the reservoir into the brake-cylinder, but this only continues until the pressure

in the brake-cylinder is such that acting in the regulating cylinder in aid of the pressure on the valve piston, the two together suffice to close the valve again against the passage of fluid from the reservoir to the brake-cylinder. Thus the pressure in the brake-cylinder is at all times dependent on the pressure in the main pipe, and whatever may be the pressure in the brake-cylinder at any time, a slight increase in the pressure in the main pipe (which is under the direct control of the engine driver or operator) causes a corresponding diminution of the pressure in the brake-cylinder; and a decrease in the pressure in the main pipe causes a corresponding increase of pressure in the regulating cylinder and in the brake-cylinder.

In the drawing hereunto annexed I have shewn four ways of arranging the valve apparatus of automatic brakes to act in the manner above described; this valve apparatus is fitted upon each of the carriages of a train that is furnished with automatic brake apparatus.

(Here follows diagram marked p. 765.)

In the arrangement shewn at figure 1, A is the inlet from the main pipe which passes from end to end of a train, and contains air or other fluid under pressure; B is the outlet to which is attached a pipe leading to the cylinders of the brake apparatus of the carriage upon which the valve apparatus is fitted; C is the passage communicating with a reservoir in which air or other fluid is stored up under pressure; and D is the outlet or exhaust passage by which the air or fluid is allowed to escape from the pipe B which leads to the brake-cylinders.

The air or other fluid under pressure passing in through the inlet A enters the lower part of a cylinder E, in which is a piston F; the upper part of this cylinder is bored to a larger diameter, and in it is a piston G which forms the regulating piston; the pistons are as shewn fixed or formed on one rod, and above the larger piston is a coiled spring H which tends always to force the pistons downwards. The spring is contained within a cap which closes
768 the top of the cylinder E as shown. From the bottom of the
cylinder E is formed a small passage I, by which air or fluid can pass from the cylinder E to a valve chamber J; the passage I is fitted with a stop-valve as shewn, to prevent any air or fluid which has entered the valve chamber from passing back to the bottom of the cylinder E. In the valve chamber J is also a slide-valve K, which in the position shew- in the drawing closes a passage from the valve chamber to the central part of the cylinder E intermediate of the two pistons which it contains, and in the arrangement shewn in this figure the slide-valve is also formed to at the same time open a communication between this part of the cylinder and the small exhaust passage D, so allowing air or fluid under pressure to escape from this part of the cylinder and from the pipe which passes from this part of the cylinder to the cylinders of the brake apparatus. The stem of the pistons F, G, is connected by a pin L with the slide-valve K, so that when the pistons are forced downwards by the coiled spring H the slide-valve is moved downwards also, and then

A. D. 1879, July 23, No 3000.
BARKER'S Specification.

FIG.4.

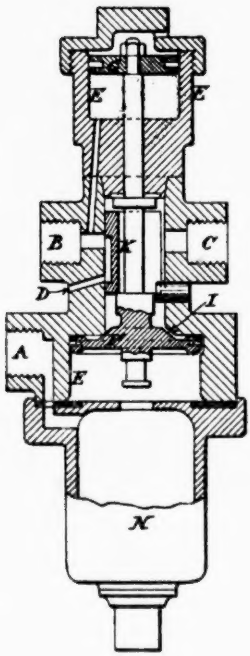
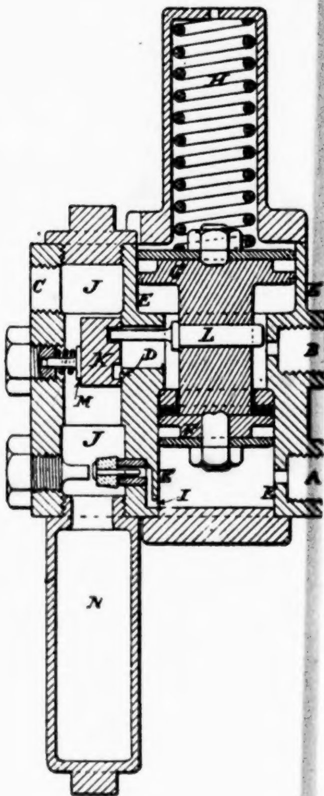


FIG.1.



closes the communication between the central portion of the cylinder and the exhaust passage, and opens a communication between this part of the cylinder and the reservoir containing air or fluid under pressure, so that this air may pass to the pipe leading to the brake-cylinders, and so cause the brakes to be applied. The slide-valve is held up to the valve seat against which it works by a small plate M pressed against the back of the valve by a coiled spring. At the bottom of the valve-chamber is a receptacle N in which if air under pressure is the fluid being used for applying the brakes any water which may be deposited from the air may collect. This receptacle may from time to time be unscrewed and emptied.

The action of the apparatus is as follows:

When air under pressure enters the inlet A it acts against the under side of the piston F, and also passes through the passage I and to the air reservoir and brake-cylinders; when the pressure on the two pistons F and G is sufficiently high to overcome the pressure of the spring H, the pistons lift into the position shewn in the drawing. Air then continues to pass through the passage I and so to the reservoir, and as the pressure rises below the piston F,
769 the piston again lifts and opens the exhaust until the downward pressure of the spring again exceeds the sum of the pressures on the two pistons, and this goes on until the pressure on the bottom of the piston F is sufficient of itself to overcome the spring; there is then a free exit for air from the brake-cylinders, whilst the pressure of air in the reservoir is maintained at the same pressure as the air in the main pipe. When however the pressure in the main pipe is reduced by letting air escape from it, the spring H forces the pistons downwards and shifts the slide-valve so that air may pass from the reservoir to the cylinders of the brake apparatus, and so soon as the pressure of the air passing to the brake-cylinders and also acting on the under side of the piston G is sufficient when added to the diminished pressure acting on the under side of the piston F to overcome the spring H the pistons again rise and shift the slide-valve, so as to cut off any further supply of air under pressure to the brake-cylinders. Thus if the effective area of the piston G is the same as the area of the bottom piston, and the pressure of air in the main pipe is reduced, say, from 60 lbs. to 30 lbs. to the inch, the pistons would be forced down by the spring H and air under pressure would pass to the brake-cylinders until the pressure of air in these cylinders had risen to 30 lbs. to the inch, the sum of the pressures on the pistons F and G would then overcome the spring H, and all further supply of air under pressure would be cut off from the brake-cylinders, and the acting pressure in these cylinders would cease to increase. Thus the pressure of air in the pipe passing to the cylinders used for applying the brakes to the wheels will be controlled by the pressure of air in the main supply pipe, and when the pressure in the main supply pipe acting on the under side of the piston is sufficient by itself to overcome the spring H, the pressure of air in the pipe leading to the brakes becomes the same as the pressure of the external air.

A precisely similar arrangement of apparatus to that above de-

scribed is shewn at figure 2, except that in the arrangement shewn at figure 2 diaphragms are used in place of pistons.

The arrangement shewn at figure 3 differs from that shewn at figure 1 in that the slide-valve K is used only to control the passage of air from the air reservoir to the pipe leading to the
770 brake-cylinders, whilst the escape of air from the pipe leading to the brake-cylinders is controlled by a separate valve O pressed down towards its seat by a coiled spring P, and held up from its seat by the pressure of air in the pipe leading to the brake-cylinders, and also by the pressure of air in the main supply pipe acting upon the bottom of a piston Q contained within a cylindrical cavity in the piston F. When the sum of the pressures upon the under side of the piston Q and the valve O are sufficient to overcome the spring P the valve O opens, but when the sum of the upward pressures is less than the downward pressure of the spring the valve closes. Thus the action of the apparatus will be precisely the same as the action of the one first described. The only difference is that in the arrangement first described one regulating piston G is used to control, not only the supply of air to the pipe leading to the brake-cylinders, but also the exit of air from this pipe; whereas in the arrangement shewn in figure 3 it only controls the supply of air to the pipe, and the exit of air from the pipe is controlled by a separate valve and regulating piston. The strength of the springs H and P should be so proportioned that the valve O shall remain closed until the sum of the pressures on the two pistons is somewhat more than sufficient to close the inlet slide-valve.

The arrangement shewn at figure 4 shews how the valve apparatus of what is known as the Westinghouse brake may have a regulating cylinder combined with it to enable the apparatus to be used as above described, so that in the ordinary working the pressure of air used for applying the brakes can be controlled and varied with the greatest ease. The same letters of reference are used as in the former figures.

When the pressure of air in the main supply pipe acts on the bottom of the piston F it holds up this piston in the position shewn. Air can then leak past the piston by the small passage I and fill the air reservoir. Afterwards if the pressure in the main supply pipe is rapidly lowered the pressure of air acting on the top of the piston is greater than on the bottom, and the piston is forced down. This shifts the slide-valve and permits air to pass from the air reservoir to the pipe leading to the brake-cylinders, and also,
771 as the drawing shews, to a cylinder in which the regulating piston G works, and when the combined pressures upon the under sides of the pistons F and G are greater than the pressure of air upon the top of the piston F the pistons will again rise and shift the slide-valve, so controlling the pressure at which the air is allowed to act in the cylinders by which the brakes are applied, as in the arrangements of apparatus previously described.

Having thus described the nature of my invention and the manner of performing the same, I would have it understood that I do not

confine myself to the precise arrangements of mechanism shewn in the drawings hereunto annexed, but I claim,—

First. The construction of automatic brake apparatus with a regulating piston or diaphragm acting substantially in the manner hereinbefore described to control the passage of air or other fluid from each of the several air or fluid reservoirs on the several carriages to the pipes leading to the cylinders of the mechanism by which the brakes are applied.

Second. The construction of automatic brake apparatus acting substantially in the manner hereinbefore described.

Third. The construction of automatic brake apparatus, substantially in the ways hereinbefore described and shewn in the drawings annexed.

In witness whereof, I, the said Edward Dunning Barker, have hereunto set my hand and seal, this twenty-second day of January, in the year of our Lord one thousand eight hundred and eighty.

EDWARD D. BARKER. [L. S.]

772 COMPLAINANTS' EXHIBIT "LICENSE NO. 1."

Filed July 10, 1893.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify, that the annexed is a true copy from the records of this office of an instrument of writing by George Westinghouse, Jr., and the Westinghouse Air Brake Company, November 22, 1880, and recorded in Liber Q 26, page 36.

Said record has been carefully compared with the original and is a correct transcript of the whole thereof.

In testimony whereof, I, Benton J. Hall, Commissioner of Patents, have caused the seal of the Patent Office to be affixed, this [SEAL.] 15th day of June, in the year of our Lord one thousand eight hundred and eighty-seven, and of the Independence of the United States the one hundred and eleventh.

BENTON J. HALL,
Commissioner.

Liber Q 26, p. 36.

Articles of agreement made and entered into this 22d day of November, 1880, by and between George Westinghouse, Jr., of Pittsburgh, Pennsylvania, party of the first part, and the Westinghouse Air Brake Company, a corporation organized under the laws of the State of Pennsylvania and having its principal place of business at Pittsburgh aforesaid, party of the second part.

Whereas, letters patent of the United States have been granted to George Westinghouse, Jr., as follows:

No. 124,404, March 5th, 1872, for improvement in steam-power air brakes and signals.

773 No. 124,405, March 5th, 1872, for improvement in steam air brakes.

No. 134,177, December 24th, 1872, for improvement in steam and air brakes.

No. 138,827, May 13th, 1873, for improvement in valve devices for steam and air brakes.

No. 141,685, August 12th, 1873, for improvement in valve devices for fluid brakes.

No. 144,006, October 28th, 1873, for improvement in steam and air brakes.

No. 149,901, April 21st, 1874, for improvement in valves for fluid brake-pipes.

No. 156,322, October 27th, 1874, for improvement in discharge valve for fluid brakes.

No. 156,323, October 27th, 1874, for improvement in tripping apparatus for air brakes.

No. 168,359, October 5th, 1875, for improvement in air valves for power brakes.

No. 172,064, January 11th, 1876, for improvement in air-brake valves.

No. 214,336, April 15th, 1879, for improvement in coupling valves.

No. 214,602, April 22d, 1879, for improvement in cocks for fluid pressure brakes.

No. 214,603, April 22d, 1879, for improvement in railway air-brake apparatus.

No. 216,545, June 17th, 1879, for improvement in operating valves for steam and air brakes.

No. 217,836, July 22d, 1879, for improvement in fluid-pressure brake apparatus.

No. 217,838, July 22d, 1879, for improvement in automatic brake relief valves.

No. 218,150, August 5th, 1879, for improvement in automatic brake attachments.

No. 220,556, October 14th, 1879, for improvement in regulating valves for automatic brakes.

No. 157,951, December 22d, 1874, for improvement in pipe coupling. Reissued June 18th, 1878. Reissue No. 8291.

774 No. 134,408, December 31st, 1872, for improvement in steam and air brakes. Reissued February 22d, 1876. Reissue No. 6948.

No. 180,179, July 25th, 1876, for improvement in air brake and signal.

No. 214,337, April 15th, 1879, for improvement in automatic brake-regulators.

No. 217,837, July 22d, 1879, for improvement in piston diaphragms for power brakes.

No. 218,149, August 5th, 1879, for improvement in fluid-pressure brake apparatus

Which said patents relate in general terms for the most part to a system of railway brake apparatus commonly known as the West-

inghouse automatic brake, which said brake apparatus, the said Westinghouse Air Brake Company, in addition to the business for which it was principally organized, has been making and selling as licensee at will of the said George Westinghouse, Jr., and under terms and at prices prescribed by him.

And whereas, the said The Westinghouse Air Brake Company desires to acquire the exclusive right to manufacture such automatic brake apparatus for passenger-locomotive and passenger-car service (with or without further improvements), and desired to procure authority to make sales of the apparatus so made, which authority the said Westinghouse is willing to grant under certain terms, conditions and limitations (but not otherwise) all as hereinafter set forth.

And whereas, certain schedule prices for the said "automatic" apparatus when sold in sets for passenger-locomotive and passenger-car service have been prescribed by the said George Westinghouse, Jr., as set forth in the printed form of agreement now in use by the said company in its dealings with its vendees, and also certain other prices for the patented parts of sets when sold for use in making repairs of full sets previously sold, which schedule prices for sets are to be hereafter maintained unless modified by consent of the said Westinghouse, and which prices of parts of sets are to be varied only in conformity with the varying cost of labor and materials employed in making the same.

775 Now these presents witness that the said George Westinghouse, Jr., for and in consideration of the sum of one dollar to him in hand paid by the said The Westinghouse Air-brake Company, at or before the execution or delivery hereof, and for other good and valuable considerations him hereunto moving, has given and granted and does hereby give and grant to the said The Westinghouse Air Brake Company, its successors, legal representatives and assigns, the exclusive right and license under each and all of the above-recited patents, to manufacture "automatic" brake apparatus, suitable for passenger-locomotive and passenger-car service (but not to sell the same except as hereinafter specified, nor to use the same except for the purpose of testing the machinery so manufactured by them, and for experimenting therewith) to the full end and expiration of the respective terms of the said patents and also a like restricted right under any patents for further improvements in "automatic" railway brake apparatus or in the detached parts thereof which the said George Westinghouse, Jr., may hereafter take out, and also a right or license restricted in its extent and exercise by the limitations hereinafter expressed and subject to the terms and conditions hereinafter named, to make sales to railway companies of the apparatus so made; which terms and conditions to the right of sale are as follows:

1st. That the said company, its successors, legal representatives or assigns, shall not make or attempt to make nor cause to be made any sale or offer of sale of any railway brake apparatus adapted or designed for use or actually used by the actual or pretended purchaser thereof for passenger locomotive or car service embodying

the "automatic" system of construction and operation or any material part of such system; at less than the present schedule prices for the same in sets, or the present price-book prices for patented parts of sets without the consent of the said George Westinghouse, Jr.

2d. That the said company shall not knowingly sell detached parts to be afterwards made up into sets, except at schedule prices for sets, nor allow the same to be done if, in its power to prevent, nor shall any rebates, reductions, drawbacks or long time
776 without interest be allowed, such as to reduce the net schedule prices above referred to, except by consent of the said George Westinghouse, Jr.

3d. In case the said The Westinghouse Air Brake Company should at any time make or attempt to make any sale in violation of or contrary to any of the limitations on which this license is granted, then the foregoing grant of license shall thereupon be forfeited, cease and determine, and every right and license herein shall revert to and be reinvested in the said George Westinghouse, Jr., and no right of use whatever or license to use under any of said patents shall accompany or go with any apparatus so sold or attempted to be sold, nor shall the said company its successors, legal representatives or assigns have any authority to grant any right of use or license to use any such apparatus so sold or attempted to be sold in violation of any of the limitations above set forth, but the said George Westinghouse, Jr., hereby reserves and shall have the right as regards any such apparatus to proceed by suit in his own name against the pretended purchasers or actual users of the same, to enjoy any use of the same, or any sale thereof, as well as to collect gains, profits and damages resulting therefrom or caused thereby; and the legal title to said patents and the control of the same, except as above granted, is hereby reserved and retained by the said George Westinghouse, Jr., but it is agreed that the selling price of detached patented parts of the said apparatus, when sold as repair goods only, may be varied from the price now fixed according as, but only as the cost of labor and material required in their manufacture may vary, and in the same relative proportion.

And for the consideration aforesaid, the said Westinghouse hereby covenants and agrees that he will when requested so to do, unite with the said company in granting a license to each one or any of the said company's vendees, authorizing such vendee to use in the manner set forth, and to the extent set forth in said compan*ies* present printed form of agreement between itself and its vendees, and not otherwise, such or so many sets of said "automatic" apparatus either as now made or as may be hereafter improved, as such vendee may purchase from said company and pay for at the full schedule rates already referred to.

777 In consideration of the foregoing license, the said The Westinghouse Air Brake Company hereby covenants and agrees that it will comply with, abide by, be bound by, maintain and observe each and every of the provisions of the terms, conditions and limitations hereinbefore expressed.

And for the consideration aforesaid, it is hereby mutually agreed

that in case of the insolvency, bankruptcy or dissolution of the said The Westinghouse Air Brake Company, or in case the said company should cease to manufacture the said apparatus so as to supply the demand therefor, then in any such case, the foregoing grant of license shall thereupon cease and determine, and all rights and license hereinbefore granted, shall at once revert to and be revested in the said George Westinghouse, Jr., his heirs, legal representatives and assigns.

And for the considerations aforesaid, it is hereby mutually agreed that the term "passenger-locomotive and passenger car-service" as used herein, shall be construed as including all locomotives employed wholly or in part in making up, switching and moving passenger cars, either separately or in trains, and also as including all cars, passenger, mail, baggage, express and other cars used or run as a part of a passenger train, and the said company may under the foregoing license, and subject to each and every of the terms, conditions and limitations, make sales of the "automatic" brake apparatus above referred to, for freight and construction train use, provided such sales are made at prices hereinbefore required on sales for passenger-locomotive and passenger-car use.

And for the considerations aforesaid it is also mutually agreed that the necessary and proper expenses of the making and perfecting of further improvements in automatic railway brake to be carried on by the said George Westinghouse, Jr., hereafter, in like manner as heretofore, shall be paid by the said The Westinghouse Air Brake Company, as also the fees, costs, and expenses of patenting the same in the United States.

All the foregoing covenants and agreements on the part of said George Westinghouse, Jr., are and shall be binding on his heirs, legal representatives and assigns.

778 Witness the hand and seal of the said George Westinghouse, Jr., and the corporate seal (duly attested) of the said The Westinghouse Air Brake Company, the day and year first above written.

GEORGE WESTINGHOUSE, JR. [SEAL.]
THE WESTINGHOUSE AIR BRAKE COMPANY.
ROB'T PITCAIRN, *Vice-Pres't.*
W. W. CARD, *Sec'y.*

Attest:
T. W. WELSH.
RALPH BAGALEY.
WM. O. N. SCULLY.
H. H. WESTINGHOUSE.
[CORPORATE SEAL.]

Recorded Feb. 7, 1881. Ex'd: E. L. L.; M. F. M.

COMPLAINANTS EXHIBIT "LICENSE NO. 2."

Filed July 10, 1893.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify, that the annexed is a true copy from the records of this office of an instrument of writing executed by George Westinghouse, Jr., November 7, 1890, and recorded in Liber L 43, page 49.

Said record has been carefully compared with the original and is a correct transcript of the whole thereof.

In testimony whereof, I, W. E. Simonds, Commissioner of Patents, have caused the seal of the Patent Office to be [SEAL.] affixed, this fourth day of August, in the year of our Lord one thousand eight hundred and ninety-one, and of the Independence of the United States the one hundred and sixteenth.

W. E. SIMONDS,
Commissioner.

779 Liber L 43, p. 49.

Erased before signing. G.W.,Jr.,G. H. C.

Whereas, George Westinghouse, Jr., of Pittsburg, Allegheny county, Pennsylvania, has procured certain letters patents of the United States, numbered, dated and entitled as follows:

[No. 225,898, March 23d, 1880, for fluid-pressure regulator.]*

No. 235,922, December 28th, 1880, for fluid-pressure brake.

No. 236,388, January 4th, 1881, for pipe coupling.

No. 240,062, April 12th, 1881, for fluid-pressure regulator for automatic brakes.

No. 243,415, June 28th, 1881, for air-brake apparatus.

No. 243,417, June 28th, 1881, for fluid-pressure brake.

No. 243,822, July 5th, 1881, for compound hose coupling.

No. 245,109, August 2d, 1881, for air-brake strainer attachment.

No. 249,128, November 1st, 1881, for pipe coupling for pneumatic railway brakes.

No. 251,490, December 27th, 1881, for valve arrangement for pneumatic railway brakes.

No. 251,980, January 3d, 1882, for regulating valve for railway brakes.

No. 270,528, January 9th, 1883, for air-brake-pressure regulator.

No. 280,269, June 26th, 1883, for fluid-pressure regulator.

No. 288,388, November 13th, 1883, for connection for railway brakes.

No. 300,543, June 17th, 1884, for apparatus for relieving pressure in brake-cylinders.

[* Words and figures enclosed in brackets erased in copy.]

No. 345,820, July 20th, 1886, for automatic brake-regulator.

No. 360,070, March 29th, 1887, for fluid-pressure automatic brake mechanism.

No. 376,837, January 24th, 1888, for fluid-pressure automatic brake mechanism.

No. 401,915, April 23d, 1889, for automatic pump-governor for brake mechanisms.

No. 425,059, April 8th, 1890, for fluid-pressure automatic brake mechanism.

No. 432,715, July 22d, 1890, for brake-cylinder head.

780 And whereas, in and by certain articles of agreement herein called agreement No. 1, bearing date the 22d day of November, 1880, and recorded in the U. S. Patent Office in Liber Q 26, page 36, of Transfers of Patents, the said George Westinghouse, Jr., *inter alia*, granted and assigned to the Westinghouse Air Brake Company, an exclusive license under certain patents therein recited, to manufacture automatic brake apparatus suitable for passenger-locomotive and passenger-car service, and also, a right to license to sell the same, such license to sell, however, being made subject to certain terms, conditions and limitations, all as therein set forth.

And whereas by the said agreement No. 1, and for the consideration therein set forth, the said The Westinghouse Air Brake Company is entitled to the same rights in and under each of the patents hereinbefore recited, subject only to the same terms, conditions and limitations.

Now these presents witness that for the considerations referred to in the premises, and in further consideration of the sum of one dollar to me in hand paid by the said The Westinghouse Air Brake Company, and for other good and valuable considerations me thereunto moving, I, the said George Westinghouse, Jr., have given and granted and do hereby give and grant to the said The Westinghouse Air Brake Company, of Pittsburg, Pennsylvania, its successors and assigns, the same exclusive right and license under each and all of the patents hereinbefore recited, as is granted in and by the said agreement No. 1 under the patents therein recited, to manufacture automatic brake apparatus suitable for passenger-locomotive and passenger-car service, throughout the whole United States and the territories thereof, to the full end and expiration of the respective terms of the patents hereinbefore recited, and also a right and license to sell to railway companies the apparatus so made, but this right to sell is hereby expressly made subject to the same terms, conditions and limitations as are by the said agreement No. 1 imposed on the right to sell therein granted, all which terms, conditions and limitations the said company, by its acceptance hereof binds itself to keep and observe in its exercise of the rights herein granted. The same right to use is also granted, as is granted in and by said agreement No. 1.

781 And whereas in and by certain other articles of agreement herein called agreement No. 2, bearing date the same day, and recorded in the U. S. Patent Office in Liber Q 26, page 30, of

Transfers of Patents, the said George Westinghouse, Jr., *inter alia*, granted and assigned to the Westinghouse Air Brake Company an exclusive license under certain patents therein recited, to manufacture automatic vacuum brake apparatus and also automatic compressed-air, freight-brake apparatus, and also a right or license to sell the same, such license to sell, however, being made subject to certain terms, conditions and limitations, all as therein set forth.

And whereas by the said agreement No. 2, and for the consideration therein set forth, the said The Westinghouse Air Brake Company is entitled to the same rights in and under each of the patents hereinbefore recited, subject only to the same terms, conditions and limitations.

Now these presents further witness that for the considerations referred to in the premises, and in further consideration of the sum of one dollar to me in hand paid by the said The Westinghouse Air Brake Company, and for other good and valuable considerations me thereunto moving, I, the said George Westinghouse, Jr., have given and granted and do hereby give and grant to the said The Westinghouse Air Brake Company, its successors and assigns, the same exclusive right and license under each and all of the patents hereinbefore recited, as is granted in and by said agreement No. 2 under the patents therein recited, to manufacture automatic vacuum brake apparatus and also automatic, compressed-air, freight-brake apparatus throughout the whole United States and the territories thereof, to the full end and expiration of the respective terms of the patents hereinbefore recited, and also a right and license to sell to railway companies the apparatus so made, but this right to sell is hereby expressly made subject to the same terms, conditions and limitations as are by the said agreement No. 2 imposed on the right to sell therein granted, all which terms, conditions and limitations the said company, by its acceptance hereof, binds itself to keep and observe in its exercise of the rights last herein granted. The same right to use is also granted as is granted in and by said agreement No. 2.

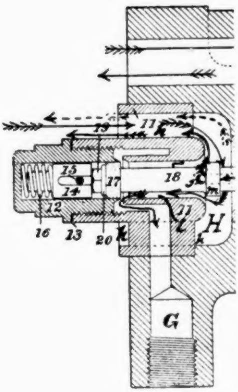
782 It is understood that since the date of said agreements Nos. 1 and 2, certain changes have been made by agreement between the parties in the schedule prices for sets and in price-book prices for parts of sets of the said passenger-train brake apparatus, and also in the net minimum prices of sets, partial sets and detached parts of the said freight-brake apparatus, and this grant and the acceptance thereof are made with such changes in view; but as regards such prices in the future, the provisions and requirements of said agreements Nos. 1 and 2 shall continue in force.

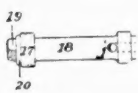
The definitions of and distinctions between "passenger-locomotive and passenger-car service," "automatic vacuum brake apparatus" and "automatic, compressed-air, freight-brake apparatus" shall herein and hereunder remain the same as in and under said agreements Nos. 1 and 2. And it is further understood and agreed that all the terms, conditions, limitations and agreements made in and by said agreement No. 1, as related to the matters therein contracted about, are hereby adopted and made a part hereof, as regards

"Compla

26 T.

(





This cut shows t
parts of the Valve,
from the body 5, a
removed for cleanir

the rights of the parties in respect of the subject-matter of automatic brake apparatus suitable for passenger-locomotive and passenger-car service, and all the terms, conditions, limitations and agreements made in and by said agreement No. 2 as related to the matters therein contracted about, are hereby adopted and made a part hereof as regards the rights of the parties in respect of automatic vacuum brake apparatus and automatic compressed-air, freight-brake apparatus, so that the matters hereof shall be as if the patents hereinbefore recited had been recited among the patents of said agreements Nos. 1 and 2, and as if also, the said agreements had been of the date hereof.

Witness the hand and the seal of the said George Westinghouse, Jr., this 7th day of November, 1890.

GEO. WESTINGHOUSE, JR. [SEAL.]

Witnesses:

GEORGE H. CHRISTY.

Recorded Nov. 10, 1890. J. F. T.; M. H.

785 *Extract from "Complainants' Exhibit Defendants' 1891 Catalogue."*

(Pages 27, 28, and 29.)

Quick-action Brake-valve.

This valve, illustrated in plate XI, is attached to the side of the auxiliary reservoir for freight brakes, (see plate X.) and to the end of the cylinder for passenger brakes, (see plate IX.)

(Here follows diagram marked p. 784.)

The branch pipe from the train-pipe is connected to the valve by a tail piece 1 and a union nut 2 which screws on the cap 3; the intervening joint between being made tight by the washer 31. The said cap is provided with a drip-chamber E, extending below the valve mechanism, to drain the water therefrom and which is done by removing the plug 4. The cap 3 is secured to the body 5 by suitable tee-head bolts 6 and the joint between is made tight by a washer 7.

The body piece 5 is provided with a cylinder D lined with the brass bushing 8; and an opening lined with a brass bushing 9 through which the sleeve F passes; an opening lined with the brass bushing 10 which is closed by the main valve 22; and a bushing 11, in which is formed the ports of the release valve.

Threaded into the release-valve bushing 11 is the abutting cap 12 provided with a washer 13 to make a tight joint.

In the abutting cap is arranged the abutting piece 14 which has a limited movement by means of a slot and the pin 15. Against the abutting piece 14 is the abutting spring 16 which forms a resistance, in graduating, to the movement of the piston 29 and the valve parts attached thereto.

The release valve is formed by a leather cup 17 secured to the valve stem 18 by a screw 19 which extends into the stem and a washer 20 that binds the cup.

The valve stem 18 has a passage with two ports which forms the graduating valve and is secured to the piston sleeve F by a screw 21. The valve stem moves through the main valve 22 which seats on the packing rings 23 and 24. Intervening between the
786 valve stem 18 and the piston sleeve F is the sleeve cap 25 which is also secured to the sleeve by the screw 21 which has each end resting in the piston sleeve F. In the piston sleeve F is arranged the check-valve 26 which is held to its seat by the check-valve spring 27, the seat of the check-valve being formed by the packing ring 28. Integral with the sleeve F is the piston 29, provided with a packing ring 30, and moves in the cylinder D according to the variations and the direction of the air pressure.

The operation is as follows:

To charge the auxiliary reservoir, the air from the train-pipe passes in through the cap 3 and moves the piston 29 to the position shown in plate XI; the air then opens the check-valve 26 and passes through the square openings in the sleeve F to the central chamber C from which it passes through the small port B into the cylinder D, which contains the piston 29, from thence it passes through the large passage A, to the auxiliary reservoir.

To apply the brakes by graduation, a slight reduction of pressure in the train-pipe moves the piston 29 and its attached parts until the shoulder on the stem 18 comes against the main valve 22, (the main valve remaining immovable on its seat owing to the pressure in the central chamber C holding it thereon); this movement draws the stem 18 through the main valve 22 sufficiently far to expose one port in the valve-stem 18 to the air pressure in the chamber C. The air then passes from the auxiliary reservoir by way of the passage A across the cylinder D, through the port B into the central chamber C, and then through the ports in the valve-stem 18 and the port in the bushing 11 to the brake-cylinder. The piston and its attached parts remain in the said position until the pressure has been sufficiently reduced in the reservoir, by passing into the brake-cylinder, to cause the piston 29 to move to the left until the end of the valve stem 18 comes in contact with the abutting piece 14 which retards the movement; when in this position the supply port in the valve stem 18 has passed into the main valve 22, which prevents any further accumulation of pressure in the brake-cylinder; while in this position the cup 17, which controls the release
787 of the air, has not moved sufficiently far to uncover the diagonal port that leads to the atmosphere, thereby holding the pressure in the brake-cylinder and exerting the desired braking force. If it is desired to increase the pressure in the brake-cylinder the above operation is repeated.

To release the brakes the maximum pressure is restored in the train-pipe which acting on the piston 29 overcomes the resistance of the spring 16, causing the piston and its attached parts to move to the position shown in plate XI which causes the release-valve

cup 17 to uncover the diagonal port and allows the air to pass from the brake-cylinder back through the bushing 11, around the stem 18, through the port uncovered by the cup 17 and from thence to the annular chamber made in the bushing 11, from which it passes through the port G to the atmosphere, the said port being threaded to receive a pipe leading to the retarding valve.

To apply the brakes fully (*not a quick action*) an amount of air is allowed to escape gradually from the train-pipe that will move the piston 29 to unseat the main valve 22 and allow air to pass from the auxiliary reservoir to the brake-cylinder through the same ports as when graduating, and in addition through that one opened by the main valve 22.

To apply the brakes fully (*by a quick action for an emergency stop*), the train-pipe pressure is suddenly reduced at the engineers' valve about 15 pounds, which quickly moves the piston 29 and its attached parts, their full stroke, this will unseat the main valve 22 and close the release-valve ports. The air from the train-pipe will then pass through the piston sleeve F opening the check-valve 26, and into the central chamber C, and as the main valve 22 is off its seat the air will pass directly from the train-pipe to the brake-cylinder. This operation is due to the co-action of three momentary pressures of the compressed air, which, approximately, are 70 pounds from the auxiliary reservoir acting on the left of the piston 29 holding it to the extreme right of its stroke; that on the train-pipe side of the piston being 55 pounds, due to the reduction in the train-pipe and 5 pounds in the central chamber C, due to the supply thereto being limited through the small port B and the discharge
788 therefrom through the port opened by the main valve 22 being so much larger. The 55 pounds pressure from the train-pipe will then lift the check-valve 26 and pass through the square openings in the piston sleeve F to the central chamber C from which it passes directly into the brake-cylinder, thereby performing two functions in quick action, to wit: partially emptying the train-pipe to quicken the action of the valve on the following car, and partially charging the brake-cylinder with the train-pipe air. After the pressure in the train-pipe and the brake-cylinder have been equalized, through the port opened by the main valve 22, the air will continue to pass from the auxiliary reservoir until there is an equalization of pressure in the auxiliary reservoir and brake-cylinder.

As the graduating valve operates without moving the main valve, it produces a uniform action on the several cars of a train, thereby avoiding jerking and lurching in stopping the same.

The actions of this valve in graduating, full-service application, quick action and the release, are the same as the new Westinghouse quick-action valve, thereby producing the same results in braking, which renders cars equipped with the two valves perfectly interchangeable—the hose couplings being the same.

The passage from the train-pipe to the brake-cylinder is the feature that produces quick action and is covered by our patent of 1883, reissued 1889.

The valve consists of the following parts:

No. 1. Tail piece.
No. 2. Union nut.
No. 3. Cap.
No. 4. Plug.
No. 5. Body piece.
No. 6. Tee-head bolts.
No. 7. Washer between cap and body.
No. 8. Brass cylinder bushing.
No. 9. Sleeve bushing.
No. 10. Main-valve bushing.
No. 11. Release-valve bushing.
789 No. 12. Abutting cap.
No. 13. Abutting-cap washer.
No. 14. Abutting piece.
No. 15. Pin for abutting piece.
No. 16. Abutting spring.
No. 17. Leather cup.
No. 18. Valve stem.
No. 19. Release-valve screw.
No. 20. Release-valve washer.
No. 21. Sleeve screw.
No. 22. Main valve.
No. 23. Small packing ring for main valve.
No. 24. Large packing ring for main valve.
No. 25. Sleeve cap.
No. 26. Check-valve.
No. 27. Check-valve spring.
No. 28. Check-valve packing ring.
No. 29. Piston and sleeve.
No. 30. Piston packing ring.
No. 31. Union washer.
No. 32. Washer between the valve and auxiliary reservoir (no shown in cut).

When ordering a special part the designating numbers should be given.

Extract from "Complainants' Exhibit Defendants' 1889 Catalogue."

(Pages 23 and 24.)

Quick-action Brake-valve.

Plate IX is a sectional view of the quick-action brake-valve in which the details are plainly shown. This valve is operated by variations of pressure in the train brake-pipe whereby the air-pressure from the brake-pipe and from the auxiliary reservoir will be admitted to the brake-cylinder and the brakes applied with any desired force, and whereby the air-pressure in the brake-
790 cylinder will be exhausted, the brakes released and the auxiliary reservoir again charged with compressed air.

The following description, with the aid of the cut will make the operation of the various parts clearly understood :

The valve is bolted to the inner head of the brake-cylinder by the flange 4, the projecting part of the head 3 extending through the cylinder head whereby the ports *a-a*, formed in the cap 21, will permit the escape of air from the interior of the brake-cylinder to the atmosphere when the release valve 17 is raised from its seat. The port *b*, which is formed in the body 1 of the valve, is connected directly with the auxiliary reservoir and provides communication therefrom to the inner surface of the piston 5 that moves in the cylinder *c*. The outer head 2 of the valve is connected by the union 22 with the train brake-pipe, so that the pressure therein will act upon the outer surface of the piston 5 and tend to move it to and hold it in the position shown in the cut.

When air pressure is admitted to the train brake-pipe to charge the auxiliary reservoir and prepare the brakes for action, this pressure will cause the piston 5 to move inward to the position shown in the cut and, in consequence of the unbalanced pressure on this side of the piston, the air will pass through the check-valve 9 therein and into the chamber *d*, whence it will pass through the port *e* to the cylinder space on the inner side of the piston 5 and then through the port *b* to the auxiliary reservoir; the air will continue to flow through these ports until the pressure in the auxiliary reservoir is equal to that in the train brake-pipe, when the check-valve 9, in consequence of the pressure exerted thereon by the spring 12, will be closed and thus communication shut off.

When it is desired to gradually apply the brakes, the pressure in the train brake-pipe will be reduced from 3 to 5 pounds, which will make an unbalanced pressure upon the piston 5 and cause it to move outward by the pressure on the inner side thereof from the auxiliary reservoir. This reduction of pressure will cause the piston 5 to move outward to such distance that the release valve 17 will be brought against its seat by the tension of its spring 20, and thus close communication between the brake-cylinder and
791 the port *f* that opens to the atmosphere; the further movement of the piston 5 will cause the graduating valve 13 to be raised from its seat and the air pressure in the chamber *d* will flow past the graduating valve into the chamber *g*, and thence through the ports *h*, with which the cap 3 is provided, into the brake-cylinder, and moves the brake-cylinder piston outward and applies the brake; the piston 5 then moves slightly inward again, and closes the graduating valve 13 when the pressure in the chamber *d* has been sufficiently reduced, thus closing all communication with the brake-cylinder and by the pressure confined therein maintain a constant and uniform pressure upon the brakes, which pressure, if desired, can be further increased by a greater reduction of the air pressure in the train brake-pipe and the admission of more air to the brake-cylinder, in the manner described.

When it is desired to release the brakes, the air pressure is again restored in the train brake-pipe which will cause the piston 5 to move to its inward position and raise the release valve 17 from its

seat, thereby permitting the air to escape from the brake-cylinder through the port *f* to the atmosphere; the air pressure from the train brake-pipe will pass through the check-valve 9 and again charge the auxiliary reservoir for future use.

When the train brakes are to be applied quickly and with full force, the pressure will be suddenly reduced in the train brake-pipe about 10 or 15 pounds, which will cause the piston 5 to be moved immediately to its extreme outward position, the release valve 17 is then brought against its seat and the plug that is integral with the piston 5 wholly withdrawn from its cylinder 16, thus presenting the full area of the latter to the flow of the air pressure from the chamber *d* to the brake-cylinder; the releasing of pressure in the chamber *d* will permit the air to escape from the brake-pipe through the check-valve 9, thereby instantly reducing the air pressure in the train brake-pipe and produce a simultaneous action of all the brakes on the train.

It will be seen this valve allows compressed air to pass to
the brake-cylinder direct from both the brake-pipe and the
792 auxiliary reservoir, which quickly applies the brakes and
produces the simultaneous action on long trains.

The valve consists of the following parts:

No. 1. Body.
No. 2. Outer head.
No. 3. Inner head.
No. 5. Piston.
No. 6. Piston packing ring.
No. 7. Cylinder lining.
No. 8. Check-valve chamber.
No. 9. Check-valve.
No. 10. Check-valve packing.
No. 11. Check-valve follower.
No. 12. Check-valve spring.
No. 13. Graduating valve.
No. 14. Graduating-valve chamber.
No. 15. Plug packing.
No. 16. Plug cylinder.
No. 17. Release-valve stem.
No. 18. Release valve.
No. 19. Release-valve packing.
No. 20. Release-valve spring.
No. 21. Cap.

In ordering a special part the designating number should be given.

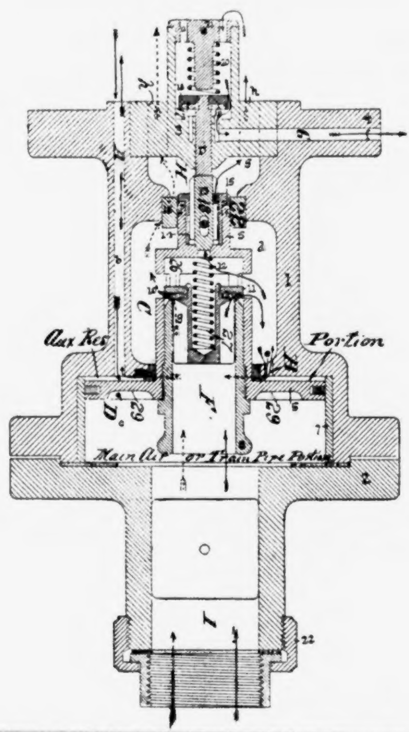
(Here follows diagram marked p. 793.)

Illustration from "Complainants' Exhibit, Defendants' 1889 Catalogue."

BOYDEN POWER BRAKE COMPANY

Plate IX.

QUICK-ACTION BRAKE-VALVE.



795 United States Circuit Court for the District of Maryland.

George Westinghouse, Jr., and The Westinghouse Air Brake Company
versus
Boyden Power Brake Company; George A. Boyden, President; Charles B. Mann, Secretary, and Wm. Whitridge, Treasurer.
In Equity. No. 321.

Depositions of witnesses and other evidence on behalf of defendants in the above-entitled cause, before George Morris Bond, a commissioner appointed by the circuit court of the United States for the fourth circuit, in and for the Maryland district, at room 546 Equitable building, in the city of Baltimore, commencing at 10.30 a. m., on Wednesday, April 26th, 1893.

Present: J. Snowden Bell, Esq., of counsel for complainants, and Lysander Hill, and Charles B. Mann, Esqs., of counsel for defendants.

Defendants' counsel offers in evidence the following exhibits, to wit:

A section of a triple valve and its casing to be marked "Defendants' Exhibit Section of Westinghouse Triple Valve of Patent No. 360,070 (Red Valve)."

Also a copy, certified by the Commissioner of Patents, of the file-wrapper and its contents in the matter of the application for letters patent granted to George Westinghouse, Jr., March 29, 1887, No. 360,070, for improvement in fluid-pressure automatic brake
796 mechanism: the same to be marked "Defendants' Exhibit Copy of Westinghouse File-wrapper, and Contents."

Also a bound package or book containing copies of specifications and drawings of patents: the same to be marked "Defendants' Exhibit Brake Patents." This exhibit contains copies of the following patents, to wit:

Geo. Westinghouse, Jr., No. 88,929, Ap'l 13, 1869.
Geo. Westinghouse, Jr., No. 124,404, M'ch 5, 1872.
Geo. Westinghouse, Jr., No. 144,006, Oct. 28, 1873.
Geo. Westinghouse, Jr., No. 168,359, Oct. 5, 1875.
Geo. Westinghouse, Jr., No. 217,838, July 22, 1879.
Geo. Westinghouse, Jr., No. 220,556, Oct. 14, 1879.
Geo. A. Boyden, No. 280,285, June 26, 1883.
Geo. Westinghouse, Jr., No. 360,070, M'ch 29, 1887.
Geo. Westinghouse. Jr., No. 376,837, July 24, 1888.
Geo. A. Boyden, No. 481,134, Aug. 16, 1892.
Geo. A. Boyden, No. 481,135, Aug. 16, 1892.
Geo. A. Boyden, No. 481,136, Aug. 16, 1892.

Also, a section of a triple valve and its casing, to be marked "Defendants' Exhibit Section of Defendants' Triple Valve, Plate XI, 1891 Catalogue."

Also, a drawing of said triple valve, to be marked "Defendants'

Exhibit Drawing of Triple Valve, Plate XI, Defendants' 1891 Catalogue."

Also, a triple valve and casing with a glass window in its side, the same being one of defendants' triple valves in a casing having a window for observing its action; to be marked "Defendants' Exhibit A."

Also, another triple valve and casing, to be marked "Defendants' Exhibit B;" the same being defendants' triple-valve piston and casing with Westinghouse main and graduating valves, and with observation window.

Also, the section of a structure similar to that of Defendants' Exhibit B, to show the internal construction of the parts; the same to be marked "Defendants' Exhibit C."

Also, a package containing ten printed illustrated drawings, to be marked "Defendants' Exhibit Illustrative Cuts," Nos. 1 to 10 inclusive.

797 GEORGE A. BOYDEN, a witness produced on behalf of the defendants, having been duly sworn, deposes in answer to interrogatories, and says as follows:

1 Q. State your name, age, residence and occupation?

A. George A. Boyden, I am 37 years old, of Baltimore city. I am a mechanical engineer and at present the president of the Boyden Brake Company.

2 Q. How long have you been engaged in mechanical pursuits and to what extent?

A. About sixteen years,—the first ten years in designing and constructing various kinds of machinery,—the last seven exclusively in designing and constructing air brakes and their adjuncts.

3 Q. Are you the George A. Boyden to whom were granted the several Boyden patents for air brakes shown in the exhibits offered in evidence this morning, and purporting to have been granted to George A. Boyden, of Baltimore?

A. I am.

4 Q. Are you familiar with the construction and mode of operation of the triple valve offered in evidence this morning as "Defendants' Exhibit Section of Westinghouse Triple Valve of Patent No. 360,070"?

A. I am.

5 Q. Do you understand the construction and operation of the four exhibits offered in evidence this morning and respectively marked as follows, to wit: "Defendants' Exhibit Section of Defendants' Triple Valve, Plate XI, 1891 Catalogue;" "Defendants' Exhibit A;" "Defendants' Exhibit B;" and "Defendants' Exhibit C"?

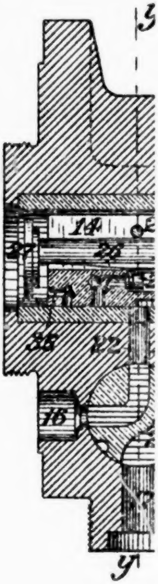
A. I do.

6 Q. Will you please describe the construction and operation of the Westinghouse quick-action triple valve shown in "Defendants' Exhibit Section of Westinghouse Triple Valve of Patent No 360,070 [red valve]"?

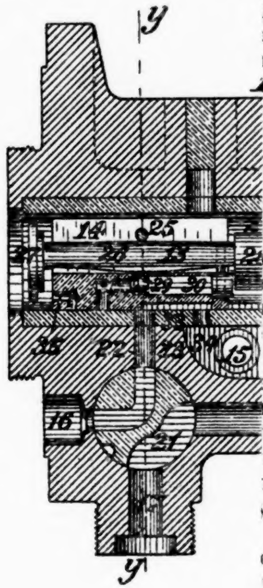
PH(

PHOTO-E

Com



Complain



A. This is a valve mechanism used in automatic air brakes, the functions of which are: 1st. To admit air from the main air
798 pipe to the auxiliary reservoir, through the valve port or
feeding-in groove 51, shown in Fig. 2 of complainants' patent No. 360,070. 2nd. To admit air from the auxiliary reservoir to the brake-cylinder through the port controlled by the graduating valve 29, by the preliminary movement of the piston 12. 3d. To admit auxiliary reservoir air to the brake-cylinder through the valve-port 35 by the final movement of the piston. 4th. To exhaust air from the brake-cylinder to the atmosphere through the valve-cavity 33. These four valves form what is commonly known as a "triple valve" proper, as used in the art prior to 1887. The operation of this triple valve is as follows: The air from the main air pipe passes to the auxiliary reservoir and charges it ready for use. When it is desired to apply the brakes with partial pressure by the preliminary movement of the piston 12, an amount of air is discharged from the main air pipe which by the consequent reduction of pressure, moves the piston 12 in the direction of the main air pipe, commonly called the "train-pipe," thereby closing the exhaust valve 33 and bringing the port 31 coincident with the passage to the brake-cylinder, at the same time unseating the graduating valve 29 and permitting air thereby to pass from the auxiliary reservoir to the brake-cylinder and apply the brakes with any desired amount of auxiliary reservoir pressure.

(Here follow diagrams marked pp. 799 & 800.)

To release the brakes, the maximum pressure is re-established in the main air pipe, which moves the piston and the valve parts back to the position shown in figure 2 of patent No. 360,070. This brings the exhaust port 33 into communication with the brake-cylinder and atmosphere, and thereby exhausts the pressure from the brake-cylinder and releases the brakes.

To apply the brakes fully with the auxiliary reservoir pressure by the final movement of the piston 12, a sufficient amount of air is gradually exhausted from the main air pipe to move the piston its full stroke. This will bring the valve port 35 coincident with
the passage 22 and thereby establish communication from
801 the auxiliary reservoir to the brake-cylinder and fully apply
the brakes with the reservoir pressure.

The brakes are released as before stated, by re-establishing the maximum pressure in the main air pipe. The operations just described are those of the "triple valve," *per se*, and are such as were used prior to 1887.

With this triple-valve mechanism is arranged and combined an "auxiliary valve," 41, shown in figure 2 of patent No. 360,070. This valve performs no functions of the triple-valve proper, but is used to perform another function, which is, admitting main air-pipe pressure directly to the brake-cylinder through passages which are independent of the triple-valve mechanism.

This valve is actuated by the piston 12 of the triple valve, and,

when open, under certain conditions, the main air-pipe pressure directly enters the brake-cylinder, thereby depleting the train-pipe pressure to a certain extent, which depletion quickens the action of the triple valves on the succeeding cars.

The essential features of the device are: 1st, the *triple valve proper*, containing sufficient valves to make it perform the triple-valve functions, and 2nd, an "*additional or auxiliary valve*," to admit the main air-pipe pressure directly to the brake-cylinder.

In the above answer, I have used the numerals of the Westinghouse patent No. 360,070, to designate the parts referred to in the exhibit. Figure 2 of said patent being the one referred to.

7 Q. Please describe the construction and operation of the defendants' quick-action triple valve in the form of its embodiment shown in "Defendants' Exhibit Section of Defendants' Triple Valve, Plate XI, 1891 Catalogue," and in "Defendants' Exhibit A."

Recess.

A. In answering this question I will use the reference letters shown in "Defendants' Exhibit Drawing of Triple Valve of Plate XI, Defendants' 1891 Catalogue."

802 I invented this valve device, and it is the outcome of a prior invention of mine, which was patented June 26th, 1883, No. 280,285. This valve mechanism is used in automatic air brakes, the functions of which are: 1st. To admit air from the main air pipe to the auxiliary reservoir. (The course of this air is through the port controlled by the check-valve 26 into the chamber C, through passages B and A to the auxiliary reservoir.) 2nd. To admit air from the auxiliary reservoir to the brake-cylinder through the graduating valve port 40, by the preliminary movement of the piston 29. 3d. To admit auxiliary reservoir air to the brake-cylinder through the port uncovered by the main valve 22, by the final movement of piston 29. 4th. To exhaust air from the brake-cylinder to the atmosphere, through the port J uncovered by the valve 17.

(Here follows diagram marked pp. 803 & 804.)

These four valves form what is commonly known as a "triple valve," as is used in the art prior to 1887. The operation of this valve mechanism is as follows: The air from the main air pipe passes to the auxiliary reservoir through the port controlled by the check-vale 26, and through the passages B and A.

When it is desired to apply the brakes with partial pressure by the preliminary movement of piston 29, air is discharged from the main air pipe, which moves the piston 29 in the direction of the train-pipe sufficiently far to close the exhaust valve 17, and withdraw the valve port 40 from the valve 22, thereby permitting auxiliary reservoir air to pass to the brake-cylinder through the graduating valve port 40, and apply the brakes with the desired degree of pressure.

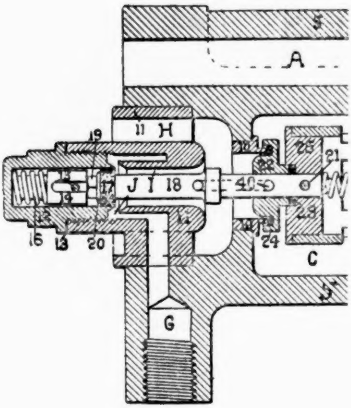
To release the brakes, the maximum pressure is restored in the

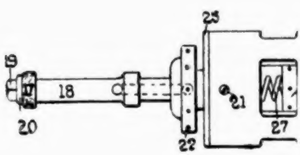
PHOTO-EN

"DEFENDANT'S EXHIB

PLATE XI, DEFEN

Defendant's Q



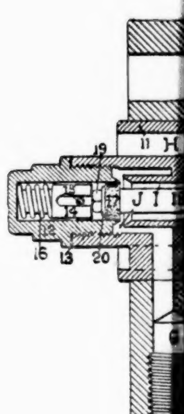


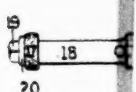
P

"DEFENDANT

PLATE X

Defend





train-pipe, which shifts the valve mechanism to the position shown in the drawing named in the question, thereby uncovering the port J and *and* permitting the air in the brake-cylinders to exhaust to the atmosphere.

To apply the brakes fully with the auxiliary reservoir pressure by the final movement of the piston, sufficient pressure is gradually exhausted from the main air pipe to move the piston its full stroke. This will unseat the main valve 22 and
805 thereby establish full communication between the auxiliary reservoir and brake-cylinder and apply the brakes with the full auxiliary reservoir pressure.

The operations just described are those of the "triple valve," *per se*, and are such as are used in the art prior to 1887.

With this triple-valve mechanism are combined the differential passages F, B and A, by which main air-pipe pressure is made to pass to the brake-cylinder through the triple-valve chamber C, and the port uncovered by the valve 22, which port also simultaneously admits the auxiliary reservoir pressure to the brake-cylinder. This depletion of the main air-pipe pressure quickens the action of the brakes on the succeeding cars.

The essential features of this device, to make it a quick-acting triple valve, are: 1st. *The triple valve proper*, which performs the triple-valve functions, and second, *the differential passages*, by which the triple valve is made to perform the additional function of admitting main air-pipe pressure to the brake-cylinder.

8 Q. Please compare the defendants' quick-acting triple valve, which you have just described, with the triple valve of your patent dated June 26th, 1883, No. 280,285, referred to in your last answer, and explain wherein the "triple valve" of your patent No. 280,285 contained the germ or suggestion of which the defendants' quick-action triple valve was the outgrowth, as stated in your last answer.

(Objected to as irrelevant and immaterial.)

A. I wish to state here that my 1883 patent was not for a "quick-action" *valve* (as that term is now understood), but it contains two essential elements which I embodied in "defendants' quick-action triple valve."

These elements are: 1st. A passage D from the main air pipe to the triple-valve chamber, in which passage is located a check-valve. 2d. A single valve H, arranged to govern a port through which the air pressure from the main air pipe and the air pressure from the auxiliary reservoir both pass to the brake-cylinder.

806 The embodiment of these features in defendants' quick-action triple valve is obvious by comparing drawings Nos. 8 and 9 in Defendants' Exhibit Illustrative Cuts.

I may here remark that in all these ten illustrative cuts the moving parts are printed in solid black to distinguish them from the stationary parts.

In drawing No. 8 it will be observed that the air from the main air pipe (as shown by the blue line), first passes through the passage F in the piston, then through the port controlled by the check-

valve into the chamber C, from which it passes to the brake-cylinder through the port uncovered by the valve 22.

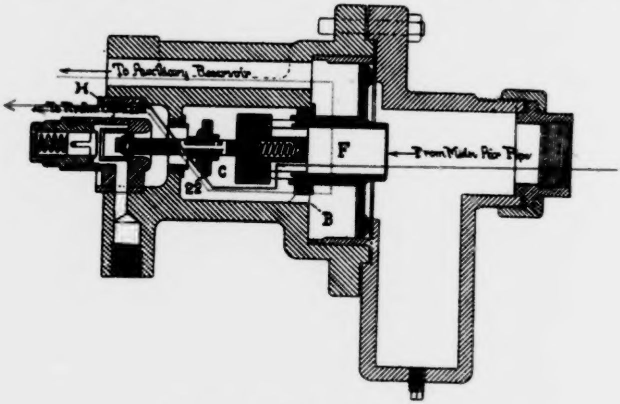
This identical feature is in my 1883 patent, as will be observed by examining drawing No. 9 of "Defendants' Exhibit Illustrative Cuts," wherein the blue line represents the passage of air from the main air pipe through the passage D in the piston, then through the check-valve port into the valve chamber, from which it passes to the brake-cylinder through the port uncovered by the valve H.

By referring to drawing No. 8, the course of the auxiliary reservoir air, in defendants' quick-action triple valve, as shown by the red lines, is from the auxiliary reservoir through the passage B into the valve chamber C, from which it passes to the brake-cylinder through the same port uncovered by the valve 22, through which also the air from the main air pipe (shown by the blue line) is admitted to the brake-cylinder. This identical feature is in my 1883 patent, as seen from drawing No. 9, in which the red line indicates the course of the air from the auxiliary reservoir through the port R^1 into the valve chamber, from which it passes to the brake-cylinder through the same port uncovered by the valve H, which admits the air from the main air pipe (as shown by the blue line).

(Here follow diagrams marked pp. 807 & 808.)

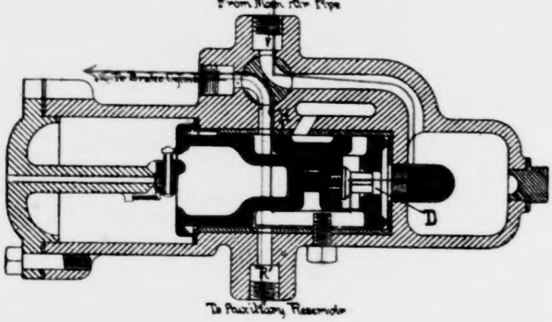
DEFENDANT'S EXHIBIT, "ILLUSTRATIVE CUTS."

Defendant's Quick Action Triple Valve.



Drawing No. 8.

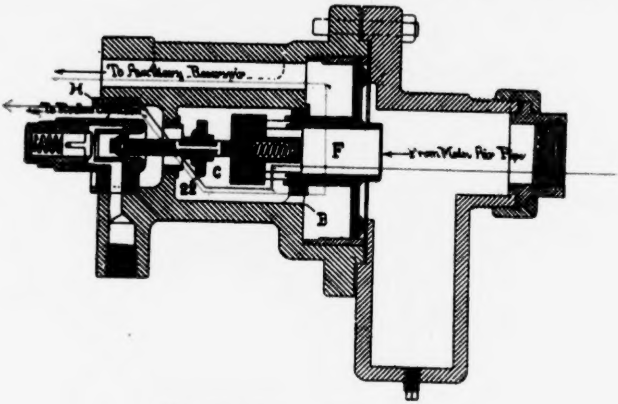
Boyden 1883 Patent.



Drawing No. 9.

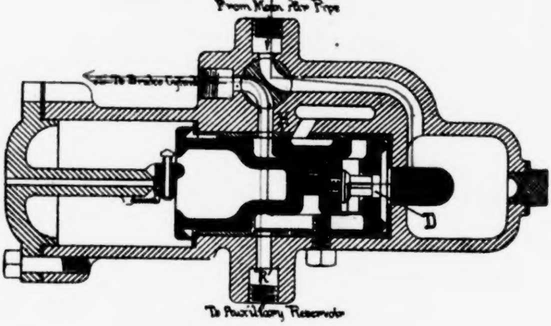
DEFENDANT'S EXHIBIT, "ILLUSTRATIVE CUTS."

Defendant's Quick Action Triple Valve.



Drawing No. 8.

Boyden 1883 Patent.



Drawing No. 9.

In both devices, train-pipe air (shown by the blue line) and auxiliary reservoir air (shown by the red line), *enter the triple-valve chamber*, and both pass to the brake-cylinder *through the same port uncovered by one valve.*

809 Having done this in my 1833 patent, I embodied these features in the "defendants' quick-action triple-valve," to which I added differential passages, and thereby produced a quick-action valve without the aid of an *auxiliary valve.*

9 Q. Please compare defendants' quick-action triple valve (I mean the form shown in plate XI of defendants' 1891 catalogue) with the quick-action triple valve of complainants' patent, No. 360,070, here in suit, and point out their similarities and differences.

A. Defendants' quick-action triple valve and complainants' patent 360,070 are both valve mechanisms used in automatic air brakes. Each of them has four functions. 1st. Admitting air from the main air pipe to the auxiliary reservoir ready for use; 2d. Admitting air from the auxiliary reservoir to the brake-cylinder to apply the brakes; 3d. Exhausting air from the brake-cylinder to the atmosphere to release the brakes, and 4th, admitting air from the main air pipe to the brake-cylinder to deplete the train-pipe pressure, thereby quickening the action of the brakes on the succeeding cars, and also increasing the pressure in the brake-cylinder over that obtainable from the auxiliary reservoir.

In comparing the two devices I will point out each valve therein, state its functions, and compare it with the corresponding valve in the other device.

I will indicate the different courses of the air in performing the different functions by colored lines on drawings "Defendants' Exhibits Illustrative Cuts," using dotted lines where the passages do not fall on the section line on which the said cuts are made.

I will first describe those valves which form the triple valve proper in the complainants' patent No. 360,070, and as I proceed I will point out the corresponding valves in the defendants' quick-action triple valve.

810 FIRST VALVE. *Feeding-in valve, whose function is to admit air from the main air pipe to the auxiliary reservoir.*

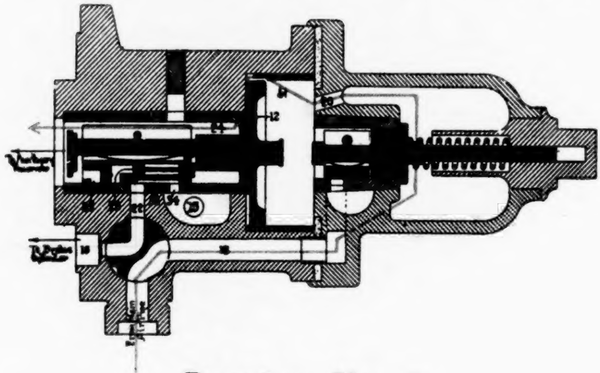
In the complainants' patent, No. 360,070, in performing the functions of charging the auxiliary reservoir the air passes from the main air pipe through the passages 17, 18 and 20, then through the feeding-in valve port 51, controlled by the piston 12, from which it passes to the auxiliary reservoir through the chamber 24.

The course of the air in performing this function is shown by a red line on cut No. 1 of the "Defendants' Exhibits Illustrative Cuts."

(Here follow diagrams marked pp. 811 and 812.)

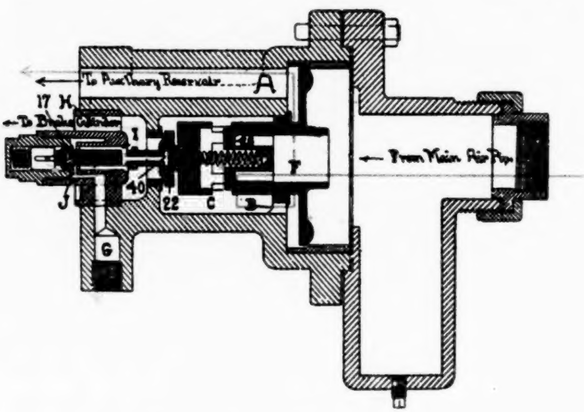
DEFENDANT'S EXHIBIT, "ILLUSTRATIVE CUTS."

Complainant's Patent No. 360,070.



Drawing No. 1.

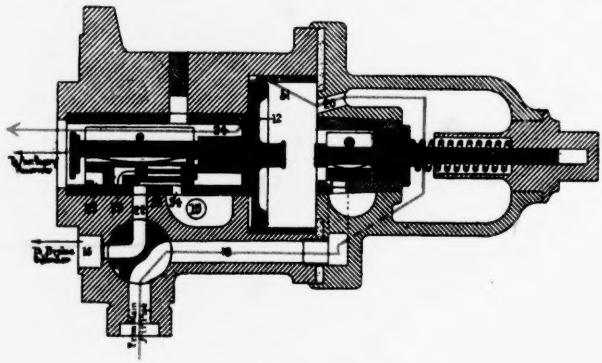
Defendant's Quick Action Triple Valve.



Drawing No. 2.

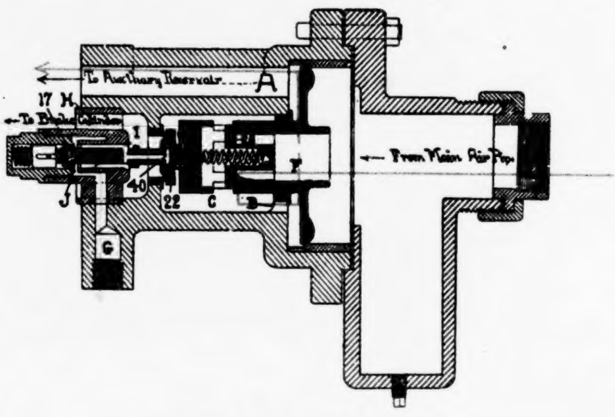
DEFENDANT'S EXHIBIT, "ILLUSTRATIVE CUTS."

Complainant's Patent No. 360,070.



Drawing No. 1.

Defendant's Quick Action Triple Valve.



Drawing No. 2.

In defendants' quick-action valve, in performing this function of charging the auxiliary reservoir, the air passes from the main air pipe through the passage F, then through the port of the check-valve 26 and passages B and A to the auxiliary reservoir.

The course of the air in performing this function is shown by a red line in defendants' quick-action triple valve on cut No. 2 of the "Defendants' Exhibits Illustrative Cuts."

Adjourned until Thursday, April 27th, 1893, at 10 o'clock a. m., at which time the testimony was resumed, the same parties and counsel being present, and the witness continued as follows:

813 SECOND VALVE. *Exhaust valve, whose function is to control the passage of air from the brake-cylinder to the atmosphere and thereby release the brakes.*

In the complainants' patent, No. 360,070, in performing the function of releasing the brakes the air passes from the brake-cylinder to the atmosphere through the passages 16, 22, valve port 33, and passages 34 and 15. The course of the air in performing this function is shown by a yellow line on cut No. 1 of illustrative cuts.

In defendants' quick-action triple valve, in performing the function of releasing the brakes, the air passes from the brake-cylinder through the passage I, then through the port J, uncovered by the valve 17, to the atmosphere through the passage G. The course of the air in performing this function is shown by a yellow line on cut No. 2.

814 THIRD VALVE. *Graduating valve, whose function is to perform part of the work of the main valve, i. e., that of admitting auxiliary reservoir air to the brake-cylinder to apply the brakes, but which may be actuated by a less pressure than the main valve and operated when the main valve is inactive.*

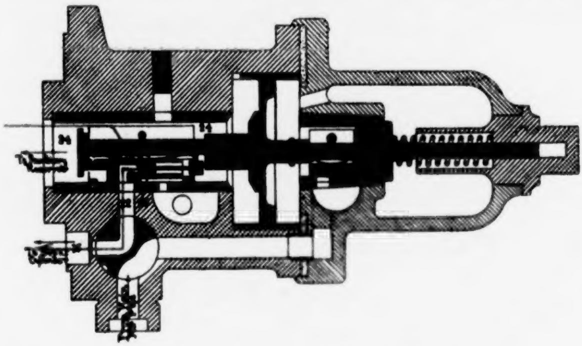
In complainants' patent, No. 360,070, in performing the above function, the air passes from the auxiliary reservoir into the valve chamber 24, then passing through the port uncovered by the graduating valve 29 to the brake-cylinder through passages 22 and 16. The course of the air in performing this function is shown by a red line on cut No. 3.

(Here follow diagrams marked pp. 815 & 816.)

In the defendants' quick-action triple valve, when performing the graduating function, the air passes through the passages A and B into the chamber C, then passes through the port 40 (forming the graduating valve) to the brake-cylinder by way of the passage H. The course of the air in performing this function is shown by a red line on cut No. 4.

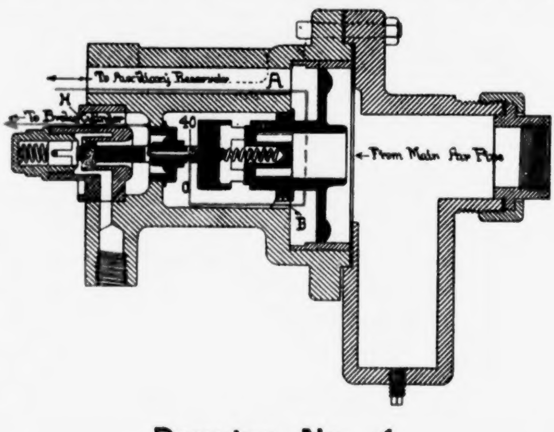
DEFENDANT'S EXHIBIT, "ILLUSTRATIVE CUTS."

Complainant's Patent No. 360,070.



Drawing No. 3.

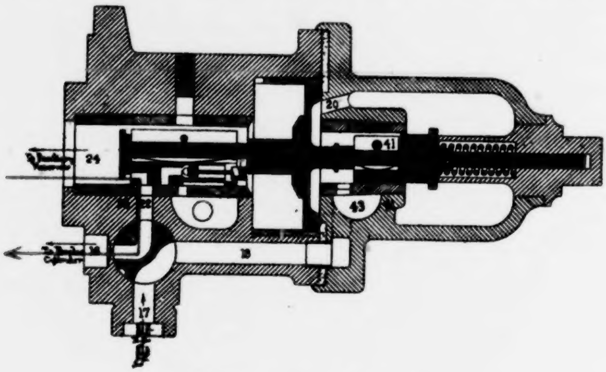
Defendant's Quick Action Triple Valve.



Drawing No. 4.

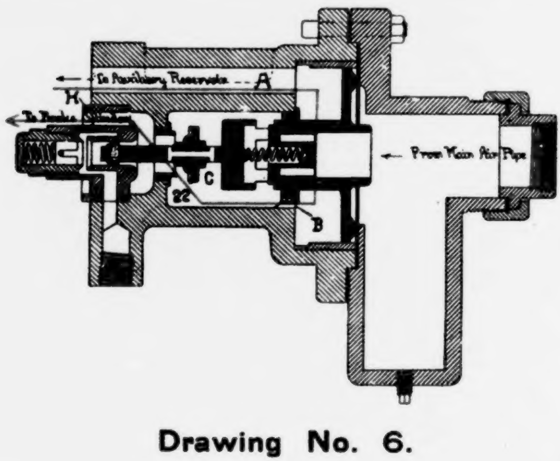
DEFENDANT'S EXHIBIT "ILLUSTRATIVE CUTS."

Complainant's Patent No. 360,070.



Drawing No. 5.

Defendant's Quick Action Triple Valve.



Drawing No. 6.

7 FOURTH VALVE. *Main valve, whose function is to admit air from the auxiliary reservoir to the brake-cylinder to apply the brakes, the same as the graduating valve, but requires for its actuation a greater pressure and operates when the graduating valve is inactive.*

In the complainants' patent No. 360,070, when performing the ove function, the air passes from the auxiliary reservoir through valve port 35, then to the brake-cylinder through the passages and 16. The course of the air in performing this function is own by a red line on cut No. 5.

In defendants' quick-action triple valve, when performing the ove function, the air passes from the auxiliary reservoir through ts A and B into the chamber C, then passes through the port covered by the valve 22 to the brake-cylinder, through the sage H.

The course of the air in performing this function is shown by a red line on cut No. 6.

8 The four valves described above form a "triple valve" proper in both the complainants' and defendants' devices, d disregarding mere matters of form are the same as are described a triple valve in complainants' patent No. 360,070, and the Westhouse patent No. 220,556, dated October 14th, 1879.

n the three devices mentioned, viz: complainants' patent No. ,070, Westinghouse patent No. 220,556 and defendants' triple-ve device, the functions of the four valves forming the "triple ve" are the same as are also the results they produce.

These valves are briefly as follows:

Complainants' patent No. 360,070.	Defendants' quick-action triple valve.
1st. Feeding-in valve 51.	1st. Feeding-in valve formed by the check-valve 26.
2d. Exhaust valve formed by the port 33.	2d. Exhaust valve formed by the valve 17.
3d. Graduating valve 29.	3d. Graduating valve formed by the port 40.
4th. Main valve formed by the port 35.	4th. Main valve formed by the valve 22.

I think the fact is obvious that if the four valves enumerated in the complainants' patent No. 360,070, form a "triple valve" proper, it follows that the four corresponding valves in the "defendants' quick-action triple valve" also form a triple valve proper, especially so as they each perform the same function, produce the same result, and operate under the same conditions.

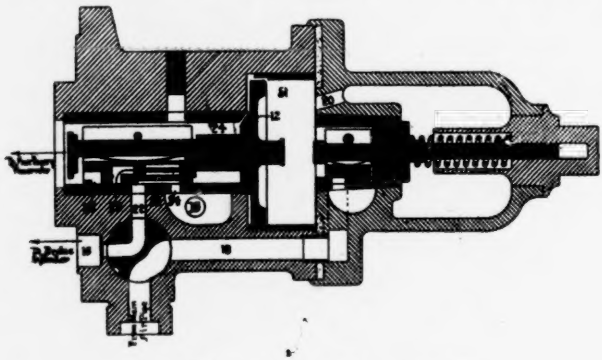
It is true, the physical structures are quite different in form, but in reality they are the same, for the reasons above given.

Having described the triple valve proper, I will now describe those parts which produce "quick action" in both complainants' and defendants' quick-action valves, using colored lines to indicate the different courses of the air, the same as when describing the triple valve.

(Here follow diagrams marked pp. 819 & 820.)

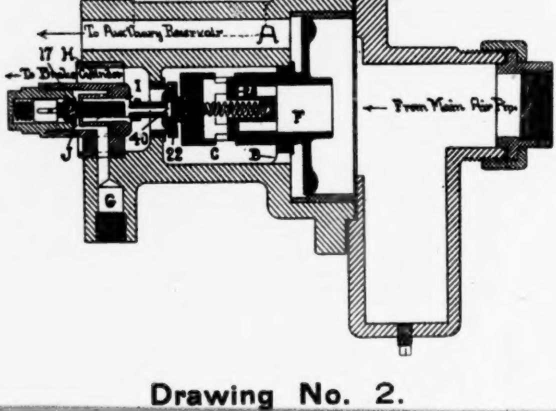
DEFENDANT'S EXHIBIT, "ILLUSTRATIVE CUTS."

Complainant's Patent No. 360,070.



Drawing No. 1.

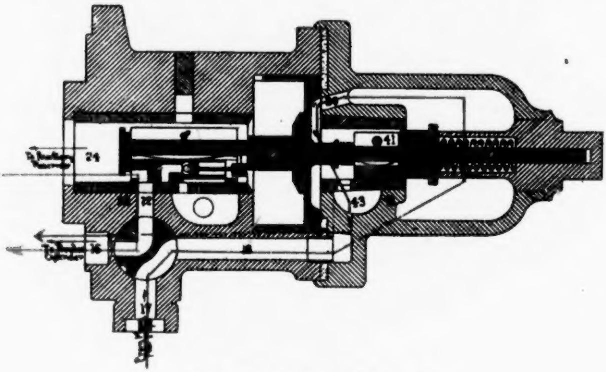
Defendant's Quick Action Triple Valve.



Drawing No. 2.

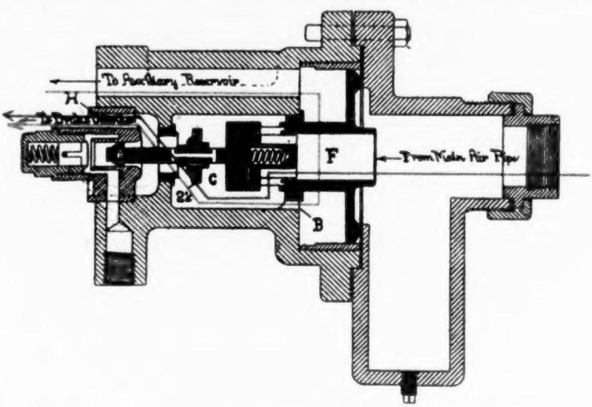
DEFENDANT'S EXHIBIT, "ILLUSTRATIVE CUTS."

Complainant's Patent No. 360,070.



Drawing No. 7.

Defendant's Quick Action Triple Valve.



Drawing No. 8.

821 *Complainants' Patent No.* 360,070.

FIFTH VALVE. *Auxiliary valve whose only function is to admit air from the main air pipe to the brake-cylinder without first passing to the auxiliary reservoir, thereby depleting the main air-pipe pressure, to quicken the action of the brakes on the succeeding cars.*

In complainants' patent No 360,070, to perform the above function, the air from the main air pipe passes through the passages 17, 18 and 20, then through the port uncovered by the valve 41 to the brake-cylinder by way of the passage 43, which is only partially shewn, as the remaining portion falls on a plane different from that on which the drawing is made. The course of the air, in performing this function, is shown by a blue line on cut No. 7, portions of said blue line being dotted, indicating the part of passage 43 not shown.

In complainants' patent No. 360,070, to apply the brakes by a quick action, the triple valve performs its function exactly the same as previously explained by me, to which is added a fifth or auxiliary valve 41, to admit air from the main air pipe to the brake-cylinder.

The number of valves shewn and described in complainants' patent No. 360,070 to perform the "triple-valve" and "quick-action" functions are five, four of which belong to the triple valve proper, and the fifth or auxiliary valve is added to admit air from the main air pipe to the brake-cylinder. This valve is an addition to the "triple valve" and performs no function of the triple valve.

In defendants' quick-action triple valve, I do not find the fifth or auxiliary valve (to admit air from the main air pipe to the brake-cylinder), but one of the four forming the triple valve proper admits the main air-pipe air to the brake-cylinder simultaneously with the auxiliary reservoir air when producing quick action.

In defendants' quick-action triple valve, to perform the quick-action function, the air passes from the main air pipe through the passage F, through the port uncovered by the check-valve into the triple-valve chamber C, then through the port uncovered by the valve 22 of the triple valve to the brake-cylinder, through the passage H. The course of the air in performing this function is shown by a blue line on cut No. 8.

822 Now, by comparing cuts 7 and 8, the fact is apparent that in the complainants' device, of patent No. 360,070, the air from the auxiliary reservoir (shown by a red line), passes through the port 35 (which forms one of the "triple valves") to the brake-cylinder, while the air from the main air pipe (shown by a blue line) passes through a port uncovered by the auxiliary valve 41 and thence through passage 43 to the brake-cylinder. This distinctly shows that the complainants' device uses two valves to perform the

quick application of the brakes, one of which belongs to the *triple valve proper* while the other is an *auxiliary valve additional* to the triple-valve structure.

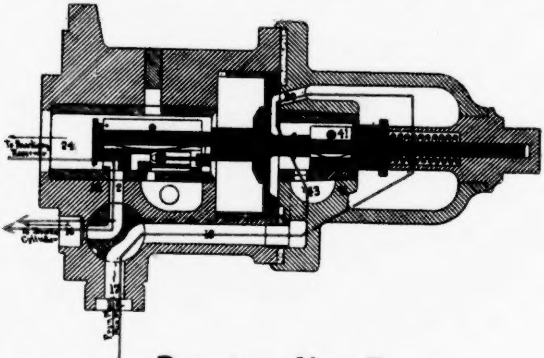
(Here follows diagram marked p. 823.)

In the defendants' quick action triple valve the air from the auxiliary reservoir (shown by a red line) passes through the port B into the chamber C, then through the *port uncovered by the valve* 22 to the brake-cylinder through the passage H, while the air from the main air pipe (shown by a blue line) passes through the same *port uncovered by the valve* 22, through which the air from the auxiliary reservoir is also passing—the valve 22 performing the double function of admitting air from both the main air pipe and auxiliary reservoir simultaneously to the brake-cylinder. Therefore, the difference between complainants' device of patent No. 360,070 and the "defendants' quick-action triple valve" is—complainants' patent No. 360,070 employs an *additional valve* to admit air from the main air pipe to the brake-cylinder, and one of the triple valves to admit auxiliary reservoir air to the brake-cylinder in producing a quick application of the brakes, whereas the defendants' quick-action triple valve admits air from the main air pipe to the brake-cylinder through the *same valve* which is *simultaneously* admitting air from the *auxiliary reservoir* in producing quick application of the brake, thereby dispensing with, or not requiring, the fifth or auxiliary valve as used in the complainants' No. 360,070, to produce the said quick action of the brakes.

Recess.

DEFENDANT'S EXHIBIT, "ILLUSTRATIVE CUTS.

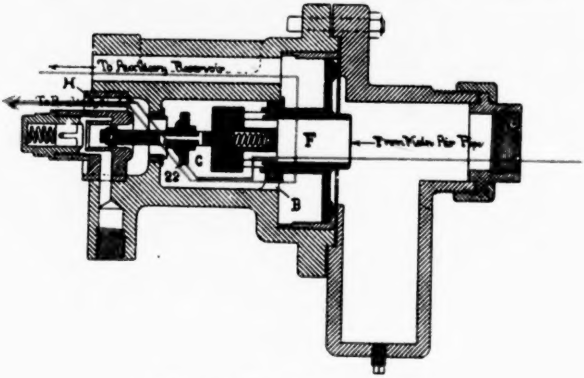
Complainant's Patent No. 360,070.



Drawing No. 7.

403 + 426.
estinghouse Co
v.
Boyden Co
p823

Defendant's Quick Action Triple Valve.



Drawing No. 8.

825 10 Q. You have, in substance, stated that the device of complainants' patent No. 360,070 performs by its triple valve the ordinary functions of a triple valve, and is further provided with an additional or auxiliary valve which operates, under certain conditions, to admit air from the main air pipe directly to the brake-cylinder in order to deplete the main air pipe more quickly and thus expedite the application of the brakes upon the succeeding cars; and that in defendants' quick-action triple valves there is no such additional auxiliary valve to perform this quick-action function, but the quick-action function is performed by the triple valve proper. Please explain to the court how and why it is that the defendant's triple valve proper is able to perform this quick-action function, which, in the complainants' structure, requires the presence and action of an additional auxiliary valve.

"Objected to as strongly leading and as making defendants' counsel a witness in so far as it assumes to state the substance of the witness' testimony; and further objected to in view of the assumption which it contains, and which counsel for complainants submits to the court as unwarranted by the witness' deposition, that the defendants' triple valve proper is able to perform the quick-action function."

A. I will explain the mode of operation by which it is possible to make the triple valve proper perform the additional function of admitting air from the main air pipe to the brake-cylinder without adding an auxiliary valve to the triple valve.

I will first briefly state the operation of the valve device shewn in complainants' patent No. 360,070, and then describe the mode of operation of the "defendants' quick-action triple valve," as shown in plat- XI defendants' 1891 catalogue.

The device shewn in complainants' patent No. 360,070 operates as follows: Supposing the device to be charged with seventy pounds of air pressure, as used in practice, and that a quick applica-
826 tion of the brakes is desired, the engineer will reduce the pressure in the main air pipe about fifteen pounds. This reduction will quickly move the piston 12 and the valve mechanism of the triple valve towards the main air pipe, the said movement being due to the preponderance of auxiliary reservoir pressure. In making this movement the piston will come in contact, by suitable intervening mechanism, with the auxiliary valve 41, and thereby open the port leading to the brake-cylinder. The air from the main air pipe at fifty-five pounds pressure will instantly pass to the brake-cylinder through the passage 43.

In the meantime the port 35 (of the main valve of the triple valve) will be placed coincident with the port 23 and in communication with passages 22 and 16, through which the air from the auxiliary reservoir passes to the brake-cylinder, thereby charging the brake-cylinder with air from both the main air pipe and auxiliary reservoir, the main air-pipe air passing through the auxiliary

valve 41, while the air from the auxiliary reservoir passes to the brake-cylinder by another valve formed by the port 35, thereby using two valves in this mode of operation.

(Here follow diagrams marked pp. 827 & 828.)

In the "defendants' quick-action triple valve," see plat- XI defendants' 1891 catalogue, the mode of operation is as follows: Supposing the device to be charged with seventy pounds of air pressure, as in practice, and that a quick application is desired, the engineer will reduce the main air-pipe pressure about fifteen pounds. This will quickly move the piston 29 towards the main air pipe, unseating the main valve 22 of the triple valve, and the air from the main air pipe will pass through the passage F (lifting the check-valve 26) into the triple-valve chamber C, and then pass through the port uncovered by the main valve 22 to the brake-cylinder.

The auxiliary reservoir pressure passes to the brake-cylinder through the same port, uncovered by the main valve 22, which is simultaneously admitting air from the main air pipe to the brake-cylinder. The means by which one valve (22) will admit
829 both main air-pipe air and auxiliary reservoir air to the brake-cylinder is as follows:

1st. The partition dividing the triple-valve chamber C from the auxiliary reservoir end of the piston chamber D; and 2nd, the differential passages A, F and B. By these differential passages, three momentary differential pressures will be established in the valve casing, when the main valve 22 is unseated to produce a *quick* application of the brakes.

These differential pressures cause one valve (22) to admit the air from the main air pipe and the air from the auxiliary reservoir simultaneously to the brake-cylinder.

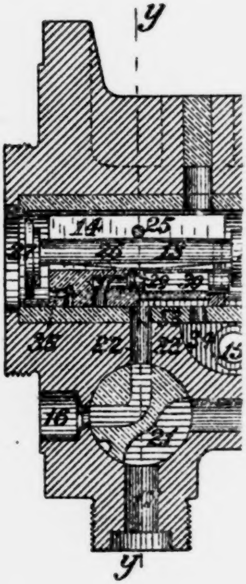
The mode of operation is as follows: It will be observed that the passage A from the auxiliary reservoir to the piston chamber D is much larger than the passage B leading from the piston chamber D to the valve chamber C, and that the port uncovered by the valve 22, when fully opened, is much larger than the passage B.

When the piston is *quickly* moved its full stroke toward the main air pipe, as when producing a quick application of the brakes, the valve 22 will be thereby unseated and its port fully opened.

This action will establish three momentary pressures, viz: 1st. Fifty-five pounds on the main air-pipe side of the piston, due to the fifteen pounds reduced by the engineer; 2d. Seventy pounds on the auxiliary reservoir side of the piston 29, due to the supply passage A from the auxiliary reservoir being so much larger than the discharge passage B, thereby partially confining the reservoir air in the space at the reservoir side of the piston; and 3rd, about five pounds in the triple-valve chamber C, due to the port uncovered by the valve 22 *being so much larger than the passage B*, that the air in the chamber C is discharged faster than can be supplied by the restricted passage B. The fifty-five pounds in the main air pipe will then lift the check valve 26 and pass into the triple-valve chamber C, from

PHOTO-I

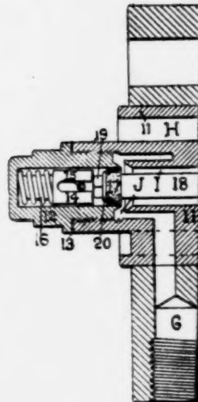
Complair

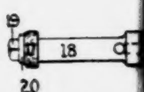


PI

"DEFENDANT'

PLATE XI.





FOLDOUTS TOO LARGE TO

which it will pass to the brake-cylinder through the large
830 port uncovered by the main valve 22, simultaneously with
the auxiliary reservoir air which is being supplied through the restricted passage B. The air from the auxiliary reservoir will continue to pass through the valve port uncovered by the valve 22, through which the main air-pipe pressure passed, until the pressure in the auxiliary reservoir and brake-cylinders will have equalized.

By this above operation, air from both the auxiliary reservoir and main air pipe will have passed to the brake-cylinder by one valve when producing a quick application of the brakes, thereby dispensing with the fifth or "auxiliary valve," as used in the operation of the complainants' device shewn in patent No. 360,070.

The essential features necessary to convert a triple valve into a defendants' quick-action triple valve are, 1st, a partition to separate the valve chamber from the piston chamber; and 2nd, differential passages, substantially as described, to establish momentary differential pressure in the triple valve.

11 Q. Referring to the partition which you have described as intervening between the piston chamber D and the valve chamber C, please state how that partition is designated in plate XI of defendants' 1891 catalogue.

A. By the numeral 9.

Adjourned to Friday, April the 28th, 1893, at 10 o'clock a. m., at which time all the aforesaid parties being present, the examination of the witness continued as follows:

12 Q. How would the removal of that partition affect the action of the triple valve, and why?

A. By removing from the defendants' quick-action triple valve the bushing 9, which forms the partition between the valve chamber C and the piston chamber D, the valve would only perform the triple-valve functions known to the art prior to 1887, which functions are, briefly, 1st, charging the auxiliary reservoir; 2d, applying the brakes by the graduating valve port 40 by a
831 slight reduction of the main air-pipe pressure, or fully applying the brakes through the port uncovered by the main valve 22 with auxiliary reservoir pressure alone, and by a greater reduction of the main air-pipe pressure than actuates the graduating valve, and 3d, releasing the brakes by discharging the air from the brake-cylinder through the port J; but by the said removal of the bushing 9, the quick application of the brakes by the admission of main air-pipe pressure to the brake-cylinder would be totally destroyed.

The reason why the quick application of the brakes would be destroyed is that by the removal of the bushing 9 the differential passages would no longer exist, and the differential pressures previously referred to could not be established, as the air from the auxiliary reservoir would pass to the chamber C as fast as it would be discharged from the said chamber C to the brake-cylinder, thereby

maintaining a pressure on the check-valve 26, which would prevent the entrance of air from the main air pipe to the brake-cylinder.

Q. 13. In testifying, in your twelfth answer, as to what effect would result from the removal of the partition or bushing 9, have you testified merely from theory and reasoning, or both from theory and from the demonstration of actual tests?

A. Both from theory and actual tests.

14 Q. Will you please state when, where and with what apparatus such tests were made, and give a full description of the tests and their results?

A. I have made a great many tests, and at various times, at the works of the Boyden Brake Company, in Baltimore, Maryland.

I have made tests on a rack equipped with fifty brakes, just as in practice, provided with all the necessary equipments. The last test I made was on the 25th of this month, in the presence of Mr. Hill, Mr. Church and Mr. Mann. I will describe this last test, which was as follows:

832 The apparatus I used consisted of an air pump, a main air reservoir and an engineer's valve, to which was connected an equipment representing the air-brake appliances as used on a freight car in practice, viz., a main air pipe, a branch pipe, an auxiliary reservoir, a brake-cylinder provided with the usual brake piston, and the triple valve, "Defendants' Exhibit A," provided with a glass window to show the movement of the interior valve mechanism. In the branch pipe was arranged a glass section, in which latter section was arranged a ball which could freely move in either direction to show in which direction the air moves in the pipes when the quick-action triple valve performs its different functions. The glass cylinder, with the ball, is shown by the sketch which I now make, offer and file as part of my answer.

(See cut illustrating the sketch of glass cylinder and ball, opposite.)

(Here follows diagram marked p. 833.)

I first removed the bushing 9 and placed the triple valve (Defendants' Exhibit A) in its proper position in relation to the brake apparatus, and charged the whole with seventy pounds of air pressure, as used in practice.

The engineers' valve was then actuated to discharge a slight amount of air from the main air pipe, sufficient to actuate the graduating valve, which opened and let a small amount of air into the brake-cylinder and then closed. The graduating valve was repeatedly opened and a corresponding small amount of air passed to the brake-cylinder each time, in graduated amounts, until the pressure in the auxiliary reservoir and brake-cylinder equalized. The brakes were then released by restoring the maximum amount of air pressure in the main air pipe.

The above operation was repeated several times, the graduating

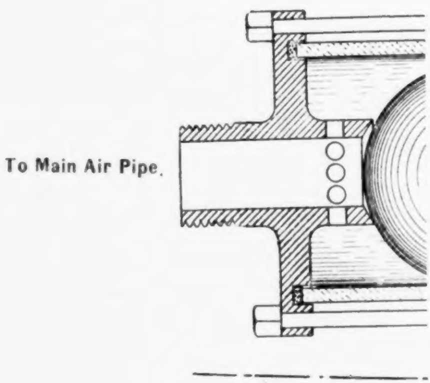
ILLU

GLASS CYL

REFERRED TC

T

W



valve operating the same in each test, as observed through the glass window in the side of the valve case.

The above operations gradually and slowly applied the brake.

The apparatus was then charged with seventy pounds of air and the engineers' valve manipulated to discharge a greater amount of air than when graduating. This unseated the main valve
835 22 and the full amount of reservoir pressure quickly passed
to the brake-cylinder through the port uncovered by the said main valve.

At the same time the ball in the glass cylinder was closely observed, but it did not move toward the brake-cylinder, showing that, although the main valve 22 was instantly unseated (as observed through the glass window,) no air passed from the main air pipe to the brake-cylinder when the bushing 9 was removed from the defendants' "quick-action triple valve." This operation was repeated several times in various ways, the engineer's valve being actuated the same as when making a quick action of the brakes, but in no instance did the ball in the glass cylinder move toward the brake-cylinder, demonstrating: 1st. That no main air-pipe air passed to the brake-cylinder; and second, that the "defendants' quick-action triple valve" with the bushing 9 removed, was strictly a "triple valve," *per se* as used prior to 1887.

The defendants' quick-action triple valve in the above demonstrations applied the brake gradually, with the graduating valve, and more quickly with the main valve, the two valves performing their functions the same as the device shewn in the Westinghouse patent No. 220,556, patented October 14th, 1879.

The bushing 9 was then replaced in its proper position in the defendants' quick-action triple valve, and then the apparatus charged with seventy pounds of air pressure. The engineer's valve was then manipulated to operate the graduating valve, which operated the same as in the preceding test.

The brakes were then released and the apparatus again charged with seventy pounds of air pressure. The engineer's valve was then operated to discharge a greater amount of air from the main air pipe than when graduating. This operation more quickly applied the brakes than when graduating, because the main valve was unseated, as observed through the glass window in the side of the valve casing.

In these operations the ball in the glass cylinder was
836 closely observed, but in no instance did the ball move toward
the brake-cylinder in the act of applying the brakes.

The apparatus was then again charged with seventy pounds of air and the engineer's valve manipulated to quickly and suddenly reduce the pressure in the main air pipe. This action quickly applied the brake and the ball in the glass cylinder instantly jumped toward the brake-cylinder, showing conclusively that when the engineer's valve was properly actuated for quick action, air passed from the main air pipe to the brake-cylinder, when the bushing 9 was in its place in the defendants' quick-action triple valve, as is normally the case in practice. The above demonstrations showed

that when the bushing 9 is removed from the "defendants' quick-action triple valve," only triple-valve functions can be obtained under any circumstances. They also shew that with the bushing 9 inserted, the defendants' quick-action triple valve performs all the triple-valve functions, and in addition thereto, the function of admitting air from the main air pipe to the brake-cylinder without the aid of an auxiliary valve in making a quick application of the brakes or, as it is termed, *an emergency stop.*

The triple valve and casing used in the tests above described was the identical structure here in evidence marked "Defendants' Exhibit A." In these tests the glass cylinder provided with the ball was slightly inclined downward from its triple-valve connection towards its main air-pipe connection, so that the ball would normally rest against the main air-pipe end of the glass cylinder, and when forced away from that position by the passage of air from the main air pipe towards the triple valve, the ball would afterwards return automatically or roll back to its normal position.

Recess.

15 Q. You have stated the fact that, in defendants' quick-action triple valve, if the bushing 9 be removed, the apparatus will
837 act simply as a triple valve, like the triple valve of the Westinghouse patent dated October 14th, 1879, No. 220,556, and that, with said bushing in its place, it will perform the same functions in the same way, and, when the engineer's valve is properly actuated for an emergency stop, the triple valve will perform the additional function of admitting air directly from the main air pipe to the brake-cylinder; I would like, now, to have you inform the court whether these results are dependent, in any way, upon the peculiar form of the graduating device, or the peculiar form of the main valve 22, of your triple valve, or whether the same results would be produced with other forms of graduating or main valves substituted for the form shown in plate XI of defendants' 1891 catalogue?

Objected to as irrelevant and immaterial.

A. It does not matter what form or class of valves is used for those shewn in defendants' quick-action triple valve.

16 Q. Is this last answer a matter of mere opinion with you, or have you demonstrated the fact experimentally?

Same objection which is continued without further notice as to this entire line of examination.

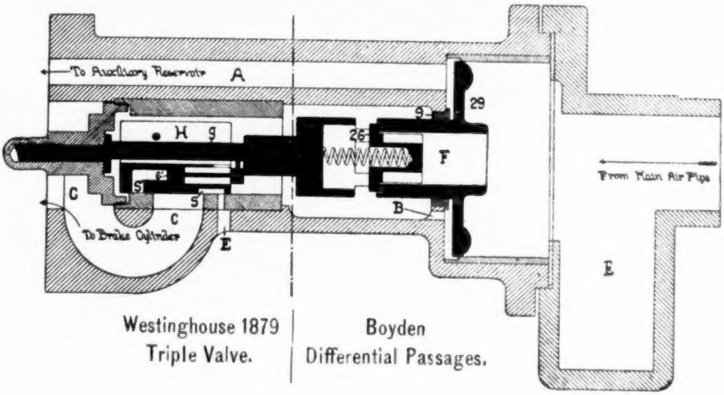
A. It is not a matter of mere opinion, as I have used various forms of valves instead of those used in the defendants' quick-action triple valve, as shewn on plate XI, defendants' 1891 catalogue.

In the device shewn in the defendants' Exhibits B and C, and cut No. 10 (of "illustrative cuts")

(Here follows diagram marked p. 838.)

DEFENDANT'S EXHIBIT, "ILLUSTRATIVE CUTS."

Westinghouse Ordinary "Triple Valve" with Boyden Differential Passages.



Drawing No. 10.

I have arranged, with the partition and differential passages of the defendants' quick-action triple valve, the slide and graduating valve mechanism of the Westinghouse patent No. 220,556, patented October 14th, 1879, and with this arrangement of the valve mechanism and differential passages of the defendants' quick-action triple valve, I have obtained the same results as with the defendants' quick-action triple valve.

17 Q. Is Defendants' Exhibit B the identical structure with which you made some of those experiments referred to in your last answer?

840 A. It is.

18 Q. Is Defendants' Exhibit C an exactly similar structure, having the valve casing cut in two, to reveal the construction of the interior parts?

A. It is.

19 Q. Please describe to the court the experiments which you made with Defendants' Exhibit B, referred to by you, stating what your tests were and what the results were.

A. I made several tests in the presence of Mr. Hill, Mr. Church and Mr. Mann at the Boyden Brake Company's works on the 25th of this month.

I used the same apparatus that I used in making the demonstrations wherein the defendants' quick-action triple valve (Defendants' Exhibit A) was used, except that I used Exhibit B in place of Exhibit A.

I first removed the bushing 9 and placed the device in its proper position in relation to the other parts of the apparatus. I then charged the apparatus with seventy pounds of air pressure and actuated the device just the same as I did when using Defendants' Exhibit A without the bushing. The results obtained were precisely the same as those obtained from Defendants' Exhibit A. I then placed the bushing 9 in its proper place and charged the whole with seventy pounds of air pressure, and actuated the device just the same as when using Defendants' Exhibit A with the bushing 9 in its proper place. The results obtained was precisely the same as those obtained from Defendants' Exhibit A.

In using the device, Defendants' Exhibit B, with the bushing removed the graduating, the main and the release valves performed their functions the same as described in the Westinghouse patent, No. 220,556, of October 14th, 1879. When the bushing 9 was put in its proper place in Exhibit B the valves performed all the triple-valve functions as above stated, and these valves of the 1879 patent, in addition, (when the engineer's valve was actuated to produce a quick application of the *the* brakes), admitted the air from

841 the main air pipe to the brake-cylinders. as observed by the ball in the glass cylinder jumping toward the brake-cylinder.

These experiments with the Defendants' Exhibit B demonstrated that the form of the valves plays no part in converting a triple valve proper into a quick-action triple valve.

20 Q. You described, in answer 14, your experiments with Defendants' Exhibit A. Please state whether Defendants' Exhibit

"Section of Defendants' Exhibit Triple Valve, Plate XI, 1891 Catalogue," is a structure exactly similar to Defendants' Exhibit A, except that it has the valve casing cut in two to reveal the construction of the interior parts.

A. It is.

21 Q. If you should take the defendants' quick-action triple valve shown in plate XI, defendants' 1891 catalogue and in Defendants' Exhibit A, and plug up the port 40, which forms the graduating valve, what effect would it have on the operation of the triple valve?

A. If the port 40 was plugged and the engineers' valve was manipulated the same as it would be to operate the graduating valve, the main valve 22 would be slightly unseated and discharge a small amount of auxiliary reservoir air to the brake-cylinder, and then close, producing the same result as though the graduating valve was not plugged, the only difference being that its action would not be quite as delicate as that of the graduating valve.

22 Q. Is this last answer a matter of mere opinion with you, or have you demonstrated it experimentally?

A. It is not a mere opinion with me, as I demonstrated that it would act as I have stated. This demonstration was made in the presence of Mr. Hill, Mr. Church and Mr. Mann, at the factory of the Boyden Brake Company on the 25th of this month. I have also demonstrated that the main valve 22 would take the place of the graduating valve, by trying the experiment on several brakes connected as they would be in practice on a train.

842 23 Q. If you have ever placed anything behind the check-valve 26, of defendants' quick-action triple valve, so as to prevent it from lifting, state the facts and the result upon the action of the valve device.

A. I have placed a comparatively strong spring back of the check-valve 26. The result of this was that it prevented the check-valve from opening, and thereby prevented the air from the main air pipe passing to the brake-cylinder, thus destroying the quick-action function of the device.

24 Q. Please refer to the quick-action brake-valve illustrated in plate IX, of defendants' 1889 catalogue, and compare that structure briefly with the structure shown in plate XI, of defendants' 1891 catalogue, and explain to the court whether there is or is not any substantial difference between said two structures in their mode of operation and practical results, or in the essential elements which act by that mode of operation to produce those results?

A. There is no difference in the mode of operation or results. The piston, partition, and the differential passages are the same, they being the elements which produce the mode of operation; the difference being that a different form of main, graduating, and release valves is used, which valves are equivalents in both devices.

25 Q. Please give a brief history of the origin and development of the air brake invented by you and used by the defendants?

A. I took out my first patent for air brake in 1883, which patent, No. 280,285, has been mentioned in my testimony. I could not use

his patent at that time, owing to the Westinghouse patents of 1872 being then in force.

About the year 1884 or 1885 I conceived an idea of a brake perated by springs and air pressure, on which I took out several atents, two being dated Nov. 8th, 1887. I incorporated a company vith several gentlemen here in Baltimore, and proceeded to perfect and put in operation the spring and air brake referred to.

43 After spending a great deal of time and money, the brake was reduced to a practical form, with many other devices ecessary to make a complete brake system, such as air pumps, overnors, engineers' valves, locomotive driver and tender brakes, ipe connections, &c.

When this was all accomplished, after two or three years of abor, we equipped a train of twenty-five refrigerator cars and a ocomotive with the above-mentioned brake equipments for the Baltimore and Ohio railroad.

This train was taken on a long trip over the heaviest grades on he B. and O. railroad. A great many tests were made under supervision of the officials of that road. This train worked entirely atisfactory in every particular during the trials, which lasted four ays. Having met with success in these experiments, we were able o interest a large number of persons, and procured sufficient capital o start in business.

At this juncture, the beginning of 1889, the question arose hether we should continue making the spring and air brake or se an air brake embodying the "automatic" features of the Vestinghouse patent No. 124,404, patented March 5th, 1872, and hich expired about this time (1889).

As the Westinghouse automatic patents had now expired, we, of ourse, were at liberty to use these devices.

Prior to 1888 I designed a quick-action valve, embodying the ssential features of the "defendants' quick-action valve"—the artition and differential passages, the check-valved passage, and he single valve to admit auxiliary reservoir and also main air-pipe ir to the brake-cylinder—the design being substantially that shown n plate IX, defendants' 1889 catalogue.

Now, having two systems of brakes, viz: the automatic quick-ction air brake, and the spring and air brake, the question arose, s before stated, what system of brakes our company should adopt, nd it was decided to adopt the quick-action air brake, owing to he fact that the Westinghouse 1872 patents had expired, thereby iving us the right to use the "automatic" features; and as the automatic class of brake was well known and intro-

44 duced, we considered that it would be easier to introduce our air brake than the spring brake.

We then established a plant here in Baltimore, and equipped it ith special machinery to manufacture our quick-action automatic ir brake.

We then began to manufacture said brakes with the necessary djuncts, such as the air pumps, governors, engineers' valves, also ocomotive driver brakes and tender brakes.

Since that time we have introduced the devices we have manufactured, on about fifty or sixty railroads, and are now continuing to supply the devices.

When we adopted our quick-action automatic air-brake system, we felt that we had a perfect right to do so owing to the fact of the expiration of the Westinghouse automatic patent, and that our quick-action valve was not an infringement on any existing patent, we considering our quick-action valve to involve a distinct and separate invention from any then in use, as it embodied a principle of our 1883 patent, and *my differential passages* by which the triple valve was made to perform the additional function of admitting main air-pipe pressure to the brake-cylinder without the addition of an auxiliary valve.

Our understanding was that the Westinghouse patent No. 360,070, was for a triple valve, to which was added an auxiliary valve, and that the defendants' quick-action triple valve was not an infringement of that patent, we being advised to that effect by Mr. C. B. Mann, patent attorney of this city.

We also procured the opinion, on this matter, of Mr. Ellis Spear, ex-Commissioner of Patents, who concurred with the views of Mr. Mann.

Adjourned to Saturday, April 29th, 1893, at 10 o'clock a. m.

Saturday, April 29th, 1893, at 10 o'clock a. m., the same parties met, and adjourned to 2 o'clock p. m. of the same day. At 2 o'clock p. m. they again met and then adjourned to Monday, the 1st day of May, 1893, at 10 o'clock a. m.

845 At which last-mentioned time they again met and proceeded as follows:

Cross-examination of Mr. George A. Boyden by J. Snowden Bell, Esq., of counsel for complainants:

X 26 Q. It is a fact, is it not, that you are familiar with letters patent for inventions, and that you were, for some time, in actual practice as a solicitor of patents in this city?

A. It is. I practiced about three years before the Patent Office as a patent solicitor.

X 27 Q. The 1889 and 1891 catalogues of the corporation defendant, copies of which are in evidence on behalf of complainants, were prepared by you, or by or under your directions and instructions, were they not?

A. Partially so. The cuts were prepared under my direction; the reading matter was prepared principally by Mr. C. B. Mann; and Mr. William L. Bailie, as I was busy at that time in mechanical matters.

X 28 Q. You were, however, familiar with both the cuts and the 1889 and the 1891 catalogues, and the same were issued with your personal approval, I presume?

A. To a certain extent, yes; but having placed the preparation of the reading matter in the hands of Mr. Bailie and Mr. Mann, I did

not give the reading matter as close scrutiny as I did the cuts. Therefore, I could testify that the cuts are absolutely correct, whereas, as to the reading matter, I am not so positive.

X 29 Q. You also devised and prepared, or caused to be made under your direction, the series of drawings offered in evidence as Defendants' Exhibits Illustrated Cuts, is this a fact?

A. It is.

X 30 Q. Do you find "the Westinghouse quick-action triple valve, shown in Defendants' Exhibit of Section of Westinghouse Triple Valve of Patent No. 360,070 (red valve)," to accord, in all substantial particulars of construction and operation, with the quick-action triple valve, described and shown in said patent No. 360,070?

846 A. As to the construction, I do find that it is like the complainants' patent No. 360,070. As to its operation in practice, I was present at its trial on fifty cars at the Burlington test in the spring of 1887. At those tests where it was operated, it did not produce the quick action to overcome the shocks between the cars at the rear of the train which it was intended to do, as set forth in complainants' patent No. 360,070, and I believe it was abandoned after those tests.

X 31 Q. I do not think that you have correctly understood my question, and I will therefore repeat cross-question thirty with the explanation that what I want to know is whether you find that the quick-action triple valve inquired about accords or agrees in all substantial particulars of construction and *mode* or *manner* of operation, with that described in patent No. 360,070.

I am not enquiring at all about the degree of perfection with which the valve operated or the degree of satisfaction attained in the results of its operation.

A. I consider the construction and mode of operation of the valve to correspond with that set forth in complainants' patent No. 360,070.

X 32 Q. Is the description of "the construction and operation of the Westinghouse quick-action triple valve shewn in Defendants' Exhibit Section of Westinghouse Triple Valve of Patent No. 360,070 (red valve)" which you give in answer six, intended by you to be taken as a statement of your understanding of the construction and mode of operation of said quick-action triple valve, as described and shewn in said patent No. 360,070, or is it a statement of your understanding of a construction or mode of operation of said quick-action triple valve differing in any particular from the construction and mode of operation shewn in said patent No. 360,070, and derived from any source other than or exterior to said patent?

A. It is partially from the specification and partially from my understanding how the device would work in practice.

847 X 33 Q. Is the description of the construction and mode or manner of operation of the Westinghouse quick-action triple valve of patent No. 360,070, which is recited in said patent, in your opinion *incorrect* in any particular, and if so, please state fully in *what* particular?

COPY BOUND TOO CLOSE IN CENTER

A. I think the specification describes the construction and mode of operation correctly, except as I recall it, it does not state how the valve would operate if a gradual and continuous limited amount of air were discharged from the main air pipe sufficient to slowly move the piston its full stroke.

The result of such action would be not to produce a quick application of the brakes, but it would bring the port 35, forming the main valve, coincident with the passage leading to the brake-cylinder, thereby partly passing the air from the auxiliary reservoir to the brake-cylinder through the port 35.

X 34 Q. In your answer six you say, as to "the Westinghouse quick-action triple valve shewn in Defendants' Exhibit Section of Westinghouse Triple Valve of Patent No. 360,070 (red valve)," that "This is a valve mechanism used in automatic air brakes, the functions of which are: 1st. * * * 2nd. * * * 3rd. * * * 4th. * * *."

Is it not the fact that one of the most *essential* and *important* functions of the "valve mechanism" referred to is, "effecting the admission of air directly from the main air pipe 2 to the brake-cylinder 7 when it is desired to apply the brakes with great rapidity and full force," as stated in lines 47 to 51, page 3, of patent 360,070.

Is it not also the fact that the function just quoted by me is not included, either directly or by implication, in either the 1st, 2nd, 3rd or 4th functions recited by you in answer six?

A. Pertaining to the first part of your question, wherein it states that I have recited four functions: When describing these functions, I was giving a description of the four valves that form a triple valve proper, and in the operation of these triple valves I do
848 not consider that the admission of main air-pipe air into the brake-cylinder is essential.

It is true, however, that, as a valve device, the quick action function is essential, but this function plays no part in the complainants' triple-valve mechanism, as it, the quick-action function, is accomplished by a valve independent of the triple valves. This auxiliary valve and its function I fully described after describing the triple valve proper.

Answer objected to as not responsive.

X 35 Q. X 34 Q. repeated, and the witness is requested to answer its two branches severally. The attention of the witness is also called to the fact that in question six he was not asked anything about "the four valves that formed the triple valve proper," but *was* asked to describe the construction and operation of "the Westinghouse quick-action triple valve shown in Defendants' Exhibit Section of Westinghouse Triple Valve of Patent No. 360,070 (red valve)?"

A. In my answer six in chief, in order to make clear what I understood the complainants' quick-action triple valve to be, I adopted the method of first describing the triple valve proper and its functions, just as the specification of complainants' patent No. 360,070 does. Afterwards I proceeded to describe those parts which were

added to the complainants' triple valve proper to make it perform the additional function of admitting the main triple air to the brake-cylinder. As the last-mentioned function did not pertain to the triple valve proper in the complainants' device, I did not enumerate it among those of the triple valve, but reserved it for the last.

In speaking of the triple valve proper, I do not consider the auxiliary-valve part of the triple valve, and especially so, as, in the complainants' patent No. 360,070, it is stated as follows: "So far as hereinbefore described, the triple valve accords, in all substantial particulars, with, and is adapted to operate similarly to, those of my letters patent Nos. 168,359, 172,064 and 220,556, and in
849 order that it may perform the further functions requisite in the practice of my present invention, it is provided with certain additional members, which will now be described."

The specification then goes on to describe an additional valve to admit the main air-pipe air to the brake-cylinder. Therefore, I do not consider that the function of admitting the main air-pipe air to the brake-cylinder has anything to do with the triple valve proper.

If, however, the complainants' device is alluded to as a whole, then one of the essential and important functions of the *valve mechanism* is to "effect the admission of air directly from the main air pipe, 2, to the brake-cylinder, 7, when it is desired to apply the brakes with great rapidity and full force."

X 36 Q. Then, if I understand you correctly, you now unhesitatingly admit that, "effecting the admission of air directly from the main air pipe, 2, to the brake-cylinder, 7, when it is desired to apply the brakes with great rapidity and full force," is one of the most *essential* and *important* functions of "the Westinghouse quick-action triple valve shown in Defendants' Exhibit Section of Westinghouse Triple Valve of Patent No. 360,070 (red valve)."

A. I do, when a quick application of the brakes is desired, but my understanding is that the triple valves proper in the complainants' device have nothing to do with performing that function, as it is performed by an additional valve auxiliary to the triple valve.

All of the last preceding answer subsequent to the word "desired" objected to as not responsive and a mere voluntary statement, the question relating in terms strictly to the exhibit before the witness, as an entirety, and having nothing to do with such portions of said exhibit whatever they may be, which the witness designates as the "triple valve proper."

X 27 Q. You will, also, I presume, unhesitatingly admit that the *essential* and *important* functions of "the Westinghouse quick-
850 action triple valve, shewn in Defendants' Exhibit Section of Westinghouse Triple Valve of Patent No. 360,070 (red valve)," is not included, either directly or by implication, in either the first, second, third or fourth functions specified by you in answer six.

Will you make this admission?

A. If the essential feature you refer to is the admission of air

from the main air pipe to the brake-cylinder I will admit the above.

Recess.

X 38 Q. Through an inadvertence on my part causing needless delay, for which I own myself responsible, cross-question thirty-seven was, as is very plainly indicated by your answer, incomplete. I will therefore put it in the form in which I should have originally put it, to wit:

You will, also, I presume unhesitatingly, admit that the *essential* and *important* function of "the Westinghouse quick-action triple valve shewn in Defendants' Exhibit Section of Westinghouse Triple Valve of Patent No. 360,070 (red valve)" to wit: "effecting the admission of air directly from the main air pipe, 2, to the brake-cylinder, 7, when it is desired to apply the brakes with great rapidity and full force is not included, either direc.ly or by implication, in either the 1st, 2nd, 3rd, or 4th functions specified by you in answer six."

Will you make this admission?

A. With the understanding that the term, Westinghouse quick-action triple valve, as used in your question, includes an auxiliary valve, I will.

X 39 Q. I call your attention to the fact that I was careful to use in cross-question thirty-eight the same language that was used in question six to designate the thing, device or structure, the construction and operation of which you were asked in question six to describe.

Did you not in answering question six, and do you not
851 now, understand that, by that language, was and is meant the *entire* structure, thing or device which it recites?

A. That is my understanding of it, but in my description of the device, I first described the triple valve proper as it existed substantially, prior to 1887, and then described that element, (the additional valve) which admits the main air-pipe air to the brake-cylinder.

X 40 Q. Your understanding being that you were asked to describe in *question six* the construction and operation of the *entire* structure, thing or device designated in the question. When you commenced your answer to question six by the statement "This is a valve mechanism used in automatic air brakes," you meant by the term "valve mechanism" which you used therein, the entire structure, thing or device, did you not?

A. Yes, I did, and by the term, "valve mechanism," I meant to apply a triple valve proper and an additional valve to admit the air from the main air pipe to the brake-cylinder.

X 41 Q. Inasmuch as you meant by the term, "valve mechanism," the entire thing, structure, or device, you were asked to describe; you will now admit, will you not, that when you stated in answer to six that the functions of that "valve mechanism" are 1st, 2nd, 3rd, and 4th, as recited in the first paragraph of that answer, you were in error in not specifying another function, to wit: the

direct admission of air from the main air pipe to the brake-cylinder, such function being as you have heretofore admitted, an essential and important function of the entire thing, structure or device you were describing?

A. No, I will not admit that I am in error, because, 1st, in describing the triple valve proper I specified the four functions which the triple valve proper produces; and 2nd, I then described the device of an additional valve to the triple valve proper, which additional valve produces the function of admitting main air-
852 pipe air to the brake-cylinder,—this not being a function performed by the complainants' triple valve proper.

X 42 Q. Inasmuch as question six makes no mention of the thing, whatever it may be, that you are pleased to term "the triple valve proper;" inasmuch as you understood question six called for the description of the entire thing, structure or device which it designated; and inasmuch as you used the term "valve mechanism" in the opening sentence of the answer, to mean the *entire* thing, structure or device, will you now maintain that you were correct in omitting the function of admitting directly air from the main air pipe to the brake-cylinder from your enumeration of the functions of the "valve mechanism" you described?

I call your attention to the fact that in commencing this description in answer six you did not say a word about the "triple valve proper," but, on the other hand, began your answer by the statement: "This is a valve mechanism used in automatic air brakes, the functions of which are 1st, * * *, 2d * * *, 3d * * * and 4th * * *

A. What I meant by "valve mechanism" was the whole of complainants' quick-action valve mechanism. In the first part of my answer I described the triple valves and their functions as forming part of the valve mechanism. In the same answer I described those parts (an additional valve) which performed the quick-action function of admitting main air-pipe air to the brake-cylinder. Therefore what I mean by "valve mechanism" is the triple valve proper, and an adtional valve to the triple valve, in the complainants' valve mechanism.

As the "auxiliary valve" of the complainants' valve mechanism does not perform any function of the triple valve proper, I could not consistently include its functions in the four functions of the triple valve proper. Therefore I was not in error at the time I described the triple valve by not including it among the triple-valve functions. However, immediately after the description of
853 the triple valve proper I described the auxiliary valve and function.

As the specifications of complainants' patent No. 360,070 first describes the triple valve proper, and then follows with a description of the auxiliary valve to perform the new functions of admitting main air-pipe air to the brake-cylinder, I followed, in my description, the order adopted in the said specification, as I considered that was the proper order in which to proceed.

X 43 Q. By reason of your frequent use of the term "the triple

valve proper," a term which I am unable to discover in question six, or in the initial clause of your answer immediately preceding your enumeration of functions, or, possibly by reason of my own obtuseness, I am still unable to understand what warrant or justification you believe you have for omitting what may be briefly termed the quick-action function from your enumeration of the functions of "the Westinghouse quick-action triple valve shown in Defendants' Exhibit Section of Westinghouse Triple Valve of Patent No. 360,070 (red valve)."

You say in answer to cross-question forty-two: "What I meant by valve mechanism was the whole of complainants' quick-action valve mechanism." Now, as you say in answer six, referring to complainants' quick-action valve mechanism. "This is a valve mechanism used in automatic air brakes, the functions of which are: 1st, * * *; 2d, * * *; 3d, * * *; 4th, * * *."

I will terminate this branch of the examination by asking you to state, for the information of the court, what warrant or justification you believe you have for omitting the quick-action function from your enumeration of the functions of the "valve mechanism" referred to by you in the first paragraph of answer six, that is to say, in your own language, "the whole of complainants' quick-action valve mechanism."

Objected to by defendants' counsel as containing, and based upon, an essential misunderstanding of the witness' answer to interrogatory six, which *did* refer to, and describe, the entire mechan-
854 ism of complainants' structure, including the *auxiliary valve* as well as the triple valve, and *did* enumerate the *fifth* function of that mechanism, to wit, the function of admitting main air-pipe air directly to the brake-cylinder. The witness' answer six must be read as a whole; and, as a whole, it fully answers the sixth interrogatory, in the broadest sense in which it is capable of being construed. But if you take a single clause of that answer, apart from the rest, it is clear that it does not, and was not intended to, cover the entire scope of the question.

Counsel for complainants submits to the court that the foregoing alleged "objection" of counsel for defendants is wholly unwarranted and entirely improper, it being upon its face a mere argument upon the record and an indication to the witness of the character of the answer, which he could make to the last preceding question. If counsel for complainants has misunderstood the witness' answer, such understanding, if there be one, is no ground for an objection, and does not, in anywise, make the question objectionable, because if the witness supposed that counsel had misunderstood his answer six, the question gave him a full opportunity of correcting such misunderstanding, if it were necessary for him to do so, in order to answer truthfully, and if it were not it would be altogether immaterial whether there was any such misunderstanding. Between a *misstatement* of the witness' testimony, and a *misunderstanding* of it, there is a wide range of difference.

The former would render the question objectionable; the latter prejudices, if at all, only the examining counsel.

Defendants' counsel replies that his objection was based exactly upon the fact that the misunderstanding which he referred to had resulted in a gross misstatement of the witness' testimony
855 given in answer six, and was put on the record to instruct complainants' counsel and not the witness. Defendants' counsel did not wish to say that complainants' counsel had misstated the testimony; because he believed that it had been done through misunderstanding of it, and he desired to call the attention of complainants' counsel to the fact that interrogatory six, in the broadest sense of its terms, had been fully and completely answered in answer six, where the witness, after describing the four first functions, peculiar to the triple valve alone, had then described the fifth function, peculiar to auxiliary valve, and had enumerated them all as coming within the terms of the *entire* structure referred to in interrogatory six.

Counsel for complainants renews his objection and protests against the impropriety of the remarks of counsel for defendants, in view of the plain instructions they convey to the witness, and further demands of counsel for defendants that he indicate to the court specifically and fully the alleged "gross misstatement" of the witness' testimony, which, in his preceding rejoinder, he has charged against counsel for complainants.

Defendants' counsel replies that the question is plainly and obviously objectionable in this, to wit: that it asks the witness what warrant or justification he has "for omitting what may be briefly termed the quick-action function from your" (his) "enumeration of the functions of 'the Westinghouse quick-action triple valve, shown in Defendants' Exhibit Section of Westinghouse Triple Valve of Patent No. 360,070 (red valve).'"

Now, the witness did not omit said quick-action function from his enumeration of the functions of "the Westinghouse quick-action triple valve shown in Defendants' Exhibit Section of the Westinghouse Triple Valve of Patent No. 360,070 (red valve)." On
856 the contrary, he clearly and fully enumerated and described it in his sixth answer; and it is a great perversion of his testimony to assume, as the present question does assume, that he omitted it. Defendants' counsel objected to the question for that reason, and, supposing the misstatement to have been unintentional, he preferred, in his objection, to use the word "misunderstanding" rather than "misstatement."

Counsel for complainants believing that the interference with his right of cross-examination, due to the instructions of defendants' counsel to the witness under the guise of objections, will be reviewed by the court at the hearing, submits thereto under protest, and will not continue this discussion further. He requests counsel for defendants, however, to state specifically, for the information of the court, whether the alleged objectionable matter in the question which is recited by defendants' counsel in his last preceding reply,

constitutes the "gross misstatement of the witness' testimony" charged by defendants' counsel in his first reply.

Defendants' counsel replies that it constitutes one of the principal misstatements of the question, but that the whole question, in its false assumption of the testimony of the witness in answer six, is practically a misstatement from beginning to end. It assumes that the witness was asked, in interrogatory six, about the entire structure; that, in commencing to answer the question, he intimated that he was answering as to the entire structure; and that he, then, went on to answer only as to the functions of the triple valve itself, without including the fifth function, to wit: the quick-action function. Any one who will intelligently read the witness' sixth answer, will see at a glance that it is capable of no such construction
857 or interpretation, and that its meaning is essentially perverted and misrepresented in the present cross-interrogatory.

The witness has, already, in his cross-examination, fully explained these facts, and shown that he understands the matter just as defendants' counsel does, and as defendants' counsel has stated in the objection here under discussion.

There is, therefore, no warrant or excuse for the intimation of complainants' counsel that the objection was made in order to lead the witness.

The objection simply embodies what the witness had in substance testified to, in his answers to the three or four cross-interrogatories immediately preceding the present one.

Counsel for complainants not being able to cross-examine more than one witness at a time, and it being now close to the hour of adjournment, instructs the witness that it is his duty to abstain during the adjournment from all communication, direct or indirect, with counsel for defendants as to the cross-question which is now awaiting his answer, and shall also abstain from consulting or referring to the arguments or statements which have been placed upon the record by the counsel for the defendants.

The witness states that he will answer the question before adjournment, and then proceeds as follows:

A. I will explain to the court my understanding of what the several terms used in my testimony mean. 1st, the term "complainants' quick-action triple-valve" means the complainants' entire structure, consisting of a triple-valve proper, or *per se*, (which performs the triple-valve functions), and an "auxiliary valve" to perform the additional function of admitting main air-pipe air to the brake-cylinder. 2nd, the term "valve mechanism" includes all of complainants' valve mechanism, the same as enumerated under the first head. 3rd, the term "triple valve proper," and the term "triple valve, *per se*," are the same, and mean those valves which only perform the triple-valve function, but do not include
858 the *additional valve* of complainants' device which admits main air-pipe air to the brake-cylinder.

In my answer to question six, my intention was to, and I did, describe all the parts of complainants' device, and I started out by

using the term "valve mechanism," meaning by that that I was going to describe the complainants' complete device.

I started by first describing the triple valve proper, and pointing out its functions. In describing the triple valve proper, I did not mention the "auxiliary valve" or its function, because, in the complainants' device, the auxiliary valve and its function had nothing to do with the functions of the triple valve.

Therefore, I could not consistently allude to the auxiliary valve when describing the *triple valve proper*. However, I immediately proceeded to describe the auxiliary valve and its function, after I described the triple valve and its functions.

This is the reason why I did not mention the auxiliary valve and its functions, in describing the triple valve proper. But, before I finished my answer to the sixth question, I fully described the "valve mechanism" of the complainants, as that term (valve mechanism) included both the triple valve proper and the "auxiliary valve."

Adjourned to Tuesday, May 2nd, 1893, at 10 o'clock a. m. At 10 o'clock a. m., Tuesday, May 2nd, 1893, the same parties pursuant to adjournment met and proceeded as follows:

X 44 Q. In your answer to cross-question 43 you say "I started by first describing the triple valve proper and pointing out its functions."

Now will you not admit that in making this statement you fell into the error of confounding what you may have desired or intended to do, with what you actually *did* do, that is to say, that instead of starting your answer by describing some portion which you selected of the entire structure enquired about and de-
859 nominated "the triple valve proper" you did, as a matter of fact, start by stating as to the entire structure enquired about that "this is a valve mechanism used in automatic air brakes, the functions of which are: 1st * * *, 2nd * * *, 3rd * * *, 4th * * *, and that after having reciting four *functions* and not described four valves, or *any* valves, you next proceeded after your recital of the functions of the "valve mechanism," to describe the operation of what you called a "triple valve" proper.

In order that you may not be misled, and may have full opportunity of correcting any mistake you may have made, I refer you to your answer to cross-question thirty-nine, in which you admitted that in answering question six you understood the language of the question to refer to the *entire* structure, thing or device which it recited.

I also refer you to your answer to cross-question forty, in which you admit that in answering question six you meant by the term "valve mechanism" the *entire* structure, thing or device inquired about.

I also refer you to your answer to cross-question forty-two, in which you state that "what I meant by 'valve mechanism' was the whole of complainants' quick-action valve mechanism" (referring to your answer six).

I also refer you to your answer to cross-question forty-three, in

which you state that: "1st, the term 'complainants' quick-action triple valve' means the complainants' entire structure * * *; 2d, the term 'valve mechanism' includes all of complainants' valve mechanism" (referring to your answer six).

Counsel for defendants say:

This question, and all questions that may be asked of the same general character, are objected to as immaterial, wasting time on frivolous verbal quibbles, said quibbles apparently being based upon the fact that the witness, in his answer six, commenced by referring to the valve mechanism (the "red valve" of the question) as an entirety, *but did not describe the whole of that entirety in his first sentence.*

860 Counsel for complainants renews his objection to and protests against the grossly improper course pursued by counsel for defendants, in continuing to instruct the witness by statements, in the guise of objections as to what the witness did say and what he did not say, and similar indications as to what he is expected to say.

Counsel for defendants replies that the good sense of the court will readily determine which of the two counsel is pursuing a "grossly improper course" in this matter.

A. I don't think I have made any error in my answer to question six. In that answer as a whole I described the complainants' entire quick-action triple valve. I first started by stating the functions of the triple valve proper and then described the operation of the triple valve. In this description I used the numerals of complainants' patent No. 360,070, to designate the valves. After this description I proceeded to describe the auxiliary valve, or those parts which admit the main air-pipe air to the brake-cylinder to produce the quick application of the brakes.

I adopted this mode of description of the complainants' quick-action triple valve, to make clear to the court what a triple valve proper was, as it existed prior to 1887, and then described those parts which produce the quick application of the brakes in complainants' quick-action triple valve.

Therefore, I don't think I have erred in my description of the device, and I think any one reading the whole of my answer to question six, with a view of ascertaining what the complainants' quick-action triple valve is, cannot fail to understand the same.

X 45 Q. While your reason for continually talking about the "triple valve proper" appears perfectly obvious from the theory attempted to be set up in your deposition, and in the "objections" of defendants' counsel, I am unable to find in question six any inquiry whatever as to the thing you call the "triple valve
861 proper," and from your answer to cross-question thirty-nine I don't find that *you* understand that it inquired about such a thing.

Now, for the information of the court, please indicate specifically any portion of question six which asks for a description of the con-

truction or operation of the thing you call the "triple valve roper?"

A. Question six refers to the entire device of the complainants' uick-action triple valve, and my answer *as an entirety* relates to he whole of complainants' quick-action triple valve, giving a de-cription of the entire device. I had to begin to describe some part f it, and I elected those parts of the triple valve proper to begin vith. Necessarily I had to use appropriate terms to denote the arts, therefore I used the term "triple valve proper" to designate hat part of the device. I think this mode of procedure is wholly onsistent, in view of the fact that Mr. Westinghouse, in applying or his patent No. 360,070, in describing to the Patent Office what is invention was, *first* described the triple valve proper, and *then* lescribed those parts which produced the quick action. Therefore feel that I am justified in describing complainants' quick-action riple valve as I did in my answer to question six.

I wish it distinctly understood that I was not attempting to "set p" a "theory" in my description of the complainants' quick-action riple valve, as the description I gave is just what the device con-ists of.

X 45½ Q. You say, in answer to cross-question forty-four (referring o your answer six): "I first started by stating the functions of the riple valve proper, and then described the operation of the triple alve."

Now, in view of the fact that the record shows that you "first tarted" by saying: "This is a valve mechanism used in automatic ir brakes, the functions of which are: 1st, * * *; 2d, * * *; d, * * *; and 4th, * * *;" and in view of the further fact n your answers to cross-questions forty, forty-two and forty-three you ave admitted that by the term "valve mechanism" you meant the entire thing, structure or device inquired about in question
62 six, please indicate specifically, for the information of the court, what language you used when you "first started" nswer six, or used prior to your recital of functions 1st, 2d, 3d and th therein which would indicate to any one capable of understand-ng the meaning of language that said recital of functions 1st, 2d, d and 4th were the functions of "the triple valve proper?"

A. I will quote the exact language I used, which is as follows: This is a valve mechanism used in automatic air brakes." I then vent on to state the functions of the triple valve proper, and the peration of the triple valve proper, as being part of the *valve nechanism.*" After the description of the triple valve proper, I pro-eeded to describe the "auxiliary valve" which admits the main ir-pipe air to the brake-cylinder, this being, or forming, the other art of the "*valve mechanism.*"

In using the term "valve mechanism" I used it to designate the levice as an entirety, and as I proceeded I used the term "triple valve proper" to designate a part of the entire device, as the "triple valve proper" is a distinct part of the device. I then proceeded to lescribe the other parts of the device, the whole forming the com-plainants' quick-action triple valve.

Objected to by counsel for complainants as not responsive.

X 46 Q. You "first started" answer six with the clause: "This is a valve mechanism used in automatic air brakes, the functions of which are;" (the punctuation being as I have given it) and immediately thereafter recited functions 1st, 2d, 3d and 4th.

Now I again ask you to indicate specifically, for the information of the court, what, if any, portion of the language used by you when you "first started" answer six (being the *only* language used by you prior to your recital of said functions, 1st, 2d, 3d and 4th), which would, in your honest opinion, indicate to any intelligent human being that you intended to recite said functions, 1st, 2d, 3d and 4th as being, not the functions of the "valve mechanism,"
863 *i. e.*, the entire thing, structure or device inquired about, but as being the functions of some selected portion or portions thereof called by you the "triple valve proper."

Defendants' counsel again protests against this line of cross-questions, as a mere waste of time on verbal quibbles, and a gross abuse of the privilege of cross-examination.

Counsel for complainants suggests that cross-examination is not a "privilege," but is a *right*, which he proposes to exercise with the full recognition of his duty to the court and to his clients.

Defendants' counsel rejoins that the law gives no right to ask immaterial questions, and to repeat them for days after their immateriality has been pointed out.

Counsel for complainants rejoins that the immateriality of questions is a matter for the determination of the court, and not one to be settled by the *dictum* of either counsel.

A. I have endeavored to answer the cross-questions intelligently, truthfully, and with candor, as I have no object to deceive the court or any one else. I have several times defined the term "valve mechanism" and what I meant by it, and I will again reiterate it.

Counsel for complainants here interrupts the witness and calls his attention to the fact that the question does not ask anything about the meaning of the term "valve mechanism" or of any other term, but simply asks him to point out to the court any portion or portions of a certain quoted passage of his testimony which would, in his opinion, convey to a reader the understanding that he meant to recite functions 1st, 2nd, 3rd and 4th as being merely the functions of the "triple valve proper."

Defendants' counsel objects that if the witness' answer 6, taken as an entirety, points out the fact referred to by complainants' counsel, it is all that is necessary; and that there is no law requiring
864 that that distinction should be stated in some particular *clause* of the answer, that the complainants' counsel chooses to select; and that answer 6, when read as a whole, *does* make the witness' meaning absolutely clear.

Counsel for complainants renews his objection and protest, and submits to the court that the witness' failure to fully answer the questions put to him in cross-examination has been largely due to

is endeavor to follow the suggestions embodied in defendants' ounsel's objections.

(The witness resumes his answer as follows:)

It means the entire structure, which includes "the essential atures of the device are, 1st, the triple valve proper, containing ufficient valves to make it perform the triple-valve functions, and econd, an additional or auxiliary valve to admit the main air-pipe ressure directly to the brake-cylinder."

In using the term "valve mechanism" I did not intend it to ean only the triple valve proper, or the auxiliary valve, or any ther special part of the device, and therefore, it is not intended to onvey the meaning of any special part or parts of the complainants' uick-action triple valve.

Objected to by counsel for complainants as wholly irresponsive.

X 47 Q. Is this the best answer which you can or will make to ross-question 46?

A. This is the best answer I can make to cross-question 46.

Recess.

X 48 Q. After having recited, in the first paragraph of your anwer 6, what you denominated the "1st," "2nd," "3rd" and "4th" unctions of the "valve mechanism" you are describing, you say:

"These four valves form what is commonly known as a
65 'triple valve proper,' and as used in the art prior to 1887,"

(having thus far in your answer made no mention whatever f the function of effecting the admission of air directly from the ain air pipe to the brake-cylinder.)

Now, will you, as a mechanical engineer and air-brake expert, retend to deny either of the three following statements of facts, to it:

(*a*) That the alleged function of the valve mechanism of patent o. 360,070, which you have recited as "3rd, to admit auxiliary eservoir air to the brake-cylinder through the valve port 35 by the nal movement of the piston 12," has nothing whatever to do with a triple valve proper, and as used in the art prior to 1887."

(*b*) That said alleged function "3rd" has nothing whatever to o with, and is not performed by, the valve mechanism of patent o. 360,070, when operating as "a triple valve proper and as used the art prior to 1887;" that is to say, when said valve mechanm is *not* operating to effect the admission of air directly from e main air pipe to the brake-cylinder.

(*c*) That said alleged function "3rd" is distinctly and specifilly recited in patent No. 360,070 as being performed when the iston 12 arrives at the extremity of its stroke, in effecting the adnission of air directly from the main air pipe to the brake-cylinder, atent, lines 43 to 51, page 4,) and that there is neither statement, int, nor suggestion, in patent No. 360,070, of such a function being erformed *under any other circumstances or conditions.*

Please answer statements (*a*), (*b*) and (*c*) severally.

A. As to statement (*a*) I do deny that statement, because in the art prior to 1887 triple valves were provided with two valves to admit the air from the auxiliary reservoir to the brake-cylinder, as is shown in patent to Westinghouse, No. 220,556, patented Oct. 14th, 1879. In this patent of 1879 is found a graduating valve (*e'*), which admits air from the auxiliary reservoir
866 to the brake-cylinder. This graduating valve is operated by the first movement of the piston and is actuated by a slight variation of air pressure in the main air pipe. This patent of 1879 also provides for admitting air from the auxiliary reservoir to the brake-cylinder by another valve, which valve is formed by the upper end of the slide-valve H. This valve H is opened by the final movement of the piston, and by a greater reduction of the pressure of air in the main air pipe than is required to manipulate the action of the graduating valve. Therefore, I find in patent No. 220,556 a valve (main valve H) corresponding to the valve formed by the port 35 in complainants' quick-action triple valve. In both the 1879 patent and the complainants' quick-action triple valve these valves perform the same functions and both are opened by the final movement of the piston.

I also deny statement (*b*), as my understanding of the complainants' quick-action triple valve is that in case the brakes were to be applied fully by the auxiliary reservoir pressure alone the engineer's valve would be placed in a position to continuously and gradually discharge the air from the main air pipe. This continued gradual discharge of air would *finally* move the piston its full stroke, and, in such an event, that air which passes from the auxiliary reservoir to the brake-cylinder would partly be supplied through the port 35.

Another instance in which this port 35 would perform a function of the triple valve proper is that if the hose connection would accidentally rupture or disconnect between the cars, the air from the main air pipe would be instantly exhausted under that car, or the pressure sufficiently lowered at that car, to prevent the main air-pipe pressure from going to the brake-cylinder, although the auxiliary valve would be open. In this event the air from the auxiliary reservoir would pass to the brake-cylinder through the valve formed by the port 35, and thereby perform the triple-valve function, when no air was admitted to the brake-cylinder from the main air pipe.

867 As to the statement (*c*), it is my understanding that patent 360,070 nowhere states that the valve formed by the port 35 performs the function of a triple valve except when producing quick action, therefore I agree with you in statement (*c*).

X 49 Q. Briefly stated, then, *you* do deny the correctness of statements (*a*) and (*b*) of cross-question forty-eight and admit the correctness of statement (*c*)?

A. Yes.

X 50 Q. Prior to the year 1887 what, if any, actual, personal and practical knowledge of, or experience in, the art as relating to air

BLEED THROUGH POOR COPY

brakes, had you? Please state fully the nature and extent of such knowledge, and experience, if any?

A. In 1883 I took out my first patent in air brakes, and from that time I began studying and investigating the air-brake subject. About 1885 I designed the spring and air brake especially for freight cars, as I at that time realized that in the near future freight cars would require power brakes. I had not got far in the spring and air brake before I realized that means would have to be provided to deplete the main air pipe of its pressure more rapidly than could be done by the engineer's valve. Therefore I designed a valve to deplete the main air-pipe pressure under each car, and afterwards put a valve of this character in practical operation on a test train of the B. and O. railroad. In the spring of 1887, prior to going to the Burlington brake test, I called Mr. C. B. Mann's attention to the fact that I could convert the valve device shown in my 1883 patent into a quick-action triple valve.

He encouraged me in this, stating that it might be likely we should want to go into the air-brake business after the expiration of the Westinghouse automatic patents.

X 51 Q. Prior to the year 1887 what, if any, actual practical or personal knowledge of or experience in the art as relating to triple valves for automatic air brakes had you?

868 A. Not any, except that I constructed a valve the same as my 1883 patent and tried it.

X 52 Q. Then I understand that your view as to "a 'triple valve' proper and as used in the art prior to 1887," expressed in your present deposition, are based merely upon your reading and study and not upon any actual knowledge of or practice with triple valves for automatic air brakes existing prior to 1887?

A. You are correct.

X 53 Q. And I also understand that you cite the Westinghouse patent No. 220,556 as fairly representing the essential features of "a 'triple valve' proper, and as used in the art prior to 1887," and as supporting the correctness of your statements as to the operation and functions of such triple valve proper.

A. Your understanding is correct.

X 54 Q. In your answer to cross-question forty-eight you say (referring to patent No. 220,556):

"In this patent of 1879 is found a graduating valve (e') which admits air from the auxiliary reservoir to the brake-cylinder. This graduating valve is operated by the first movement of the piston, and is actuated by a slight variation of pressure in the main air pipe. This patent of 1879 also provides for admitting air from the auxiliary reservoir to the brake-cylinder by another valve, which valve is formed by the upper end of the slide-valve H. This valve H is opened by a final movement of the piston, and by a greater reduction of the pressure of air in the main air pipe than is required to manipulate the action of the graduating valve."

Your views as to the triple valve of patent No. 220,556 being, as admitted in your answer to cross-question fifty-two, based merely upon your reading and study, and not upon actual knowledge of or

practice with triple valves, prior to 1887, please quote upon the record fully for the information of the court any passage or passages of the specification of patent No. 220,556 which you understand provides for the admission of air from the auxiliary reservoir to the brake-cylinder by a valve other than the graduating valve,
869 as you have alleged in the portion of your answer to cross-question forty-eight, above quoted by me?

A. I do not find in the specification any mention made of the admission of auxiliary reservoir air to the brake-cylinder by the main valve H, but it is perfectly obvious to any one who is familiar with reading drawings that the upper end of the valve H can pass to the lower side of the port C leading to the brake-cylinder. This is made plain by measuring the full stroke of the piston and comparing that measurement with the distance from the upper end of the valve to the lower side of the port C, leading to the brake-cylinder. The opening of this valve would occur in case the hose connections between the cars should burst, or a large amount of main air-pipe air would be discharged at the engineer's valve by the engineer in case it was desired to fully apply the brake in case of an accident or otherwise, as by the opening of the valve H the air could pass from the auxiliary reservoir to the brake-cylinder much quicker than if passing through the graduating valve, the whole structure being intended to operate this way, and would operate this way, when the brakes were to be applied with their full force as quickly as possible.

All of the foregoing answer subsequent to these words "the main valve H," in the first clause thereof, objected to by counsel for complainants as not responsive and a mere volunteer statement.

Adjourned to Wednesday, May 3d, 1893, at 10 o'clock a. m.

The same parties met on May 3d, 1893, at 10 a. m., pursuant to adjournment, and proceeded as follows:

X 55 Q. Please quote any passage of patent No. 220,556 which states, either directly or in substance, that the valve H of said patent is opened by a final movement of the piston and by a greater reduction of the pressure of the air in the main air pipe than
870 is required to manipulate the action of the "graduating valve," as is alleged by you to be the case in your answer forty-eight.

A. I did not state that there was any passage or lines in the specification which stated that the valve H admitted air from the auxiliary reservoir to the brake-cylinder, or that the specification contained a passage or lines in which it was stated that the valve was opened by the final movement of the piston, but I did assert that such was the case in reality, and I think any one who is familiar with patents and patent drawings would agree with me, as it is evident that if the piston was moved its full stroke the valve H would be moved to uncover the port C, and thereby admit the air from the auxiliary reservoir to the brake-cylinder in a greater volume than it could be admitted by the graduating valve. I am

thoroughly satisfied that persons who handle the brake practically will agree with my view, and I am satisfied that counsel for complainants knows that my assertions as to how the valve H operates are correct.

In further proof of my statement being correct I will refer to the Westinghouse catalogue of 1886, (see stipulation complainants' printed record, page 231,) and call the attention of the court to the 4th line, which pertains to applying the brakes with the slide-valve of the 3rd paragraph, page 10. "As the piston descends, it moves with it the slide-valve 6," (slide-valve H in patent,) "so as to permit air to flow *directly* from the auxiliary reservoir to the brake-cylinder which forces the piston out and applies the brakes;" and also to lines 11 to 17, both inclusive of the same 3rd paragraph, which lines pertain to applying the brakes gently through certain passages or openings in the slide-valve, which are opened and closed by a small valve 7, [the graduating valve (*é*)] of the patent No. 220,556.

Objected to by counsel for complainants as not being in the slightest degree responsive to the question.

X 56 Q. In your answer 48 you did not say anything
871 about what was the case in reality, or what you supposed would be the case in reality, but what you *did* say was: "In this patent of 1879 (patent No. 220,556) is found a graduating valve (*e'*), which admits air from the auxiliary reservoir to the brake-cylinder. This graduating valve is operated by the first movement of the piston and is actuated by a slight variation of air pressure in the main air pipe. This patent of 1879 also provides for admitting air from the auxiliary reservoir to the brake-cylinder by another valve, which valve is formed by the upper end of the slide-valve H. This valve H is opened by the final movement of the piston, and by a greater reduction of the pressure of air in the main air pipe than is required to manipulate the action of the graduating valve."

Now, will you please indicate, if you can, any portion of the specification of patent No. 220,556 which states, either directly or in substance, that the valve H is opened by the final movement of the piston, and by a greater reduction of the pressure of air in the main air pipe than is required to manipulate the action of the graduating valve?

A. I do not find any paragraph, passage or line in the printed specification which refers to the above, but the drawing unmistakably discloses or shows that my statement in answer to question 48 is true.

All of the foregoing answer after the first clause thereof objected to by counsel for complainants as not responsive and is a mere volunteer statement.

X 57 Q. Then, if I understand you correctly, the statements made by you in answer 48 as to patent No. 220,556 and quoted by me in cross-questions 54 and 56 are not based upon anything whatever that is recited in the specification of said patent, but are merely

statements of your opinion based upon your reading and study and not upon any practical knowledge of or experience in the use of triple valves similar to that set forth in patent No. 220,556. Am I correct?

A. You are partly correct, inasmuch as the printed specifi-
872 cation does not mention the action of the valves as mentioned
by you under discussion, but as the printed specification is only part of the patent and the drawing another part, it is perfectly permissible to read from either drawing or printed specification, as together, they form the description of the patent.

In one of my preceding answers I stated that I had no practical experience with triple valves prior to 1887, but since that time I have had considerable practical experience. Therefore, I now interpret the patent from its drawing based upon what I actually know about triple valves. It is customary to refer to the drawing for information that the printed specification does not give, or *vice versa.* As the specification in the patent No. 220,556 does not mention how and when the valve H is opened, I have used the drawing therein to determine, and I am sure the device operates just as I have stated.

X 58 Q. What, if any practical knowledge of or experience in the use of triple valves, similar to that set forth in patent No. 220,556 have you had either before or after 1887?

A. I have had valves which were made in exact accordance with patent No. 220,556 at our shop, the works of the Boyden Brake Company, where I have operated them in various ways in connection with the valves made by the Boyden Brake Company, thereby becoming perfectly familiar with their operation. I have, also, experimented with trains on the B. and O. railroad, and the B. and O. Southwestern railroad partly made up with cars equipped with brakes having Westinghouse triple valves the same as in patent No. 220,556 and partly made up with cars equipped with our triple valve, and in these experiments I have learned that the Westinghouse triple valve shown in patent No. 220,556 operates as I have stated.

X 59 Q. How many valves which were made "in exact accordance with patent No. 220,556," did you have at your shops, how many of them did you operate, and in what manner did you operate them?

A. I don't think I had more than two at any one time.
873 I have operated them by themselves and in connection with
valves made by us. These operations were made on a testing rack at our works by operating the graduating valve, and thereby intermittingly applying the brakes with a slight reduction of main air-pipe pressure; and by operating them to open the port governed by the main valve H by a considerable reduction of main air-pipe pressure.

This last operation would more quickly apply the brakes than could be accomplished by the use of the graduating valve (e') alone.

X 60 Q. When you say in answer 48 (referring to patent No. 220,556), "This valve H is opened by the final movement of the

piston, and by a greater reduction of the pressure of air in the main air pipe than is required to manipulate the action of the graduating valve," you mean, I suppose, opened "so as to uncover the port C," and would be satisfied to have your answer to question 48 read as if the words last quoted were included. Am I correct?

A. You are.

X 61 Q. And I understand that you believe an operation of the triple valve of patent No. 220,556, in which the valve H is opened (so as uncover the port C) by the final movement of the piston, and by a "greater reduction of the pressure of air in the main air pipe than is required to manipulate the action of the graduating valve," to be an *intended*, and, in practice, a *normal* operation of the valve set forth in patent No. 220,556. Am I correct?

A. You are.

X 62 Q. Such being your belief, I presume you also believe and assert that this supposed function of the triple valve of patent No. 220,556, *i. e.*, the operation recited in the last preceding question, would be performed by all of the several triple valves of a train of, say 20 or 25 cars, each equipped with a triple valve similar to that of patent No. 220,556 and with the proper connections, whenever what you term in answer 48 "a greater reduction of the pressure of air in the main air pipe than is required to manipulate the
874 action of the graduating valve," is made by the engineer of the train. Am I correct?

A. In a case of this kind I should say the operation would be about as follows: Supposing it was desired to stop the train as quickly as possible, the engineer would place the engineers' valve in a position to fully exhaust the main air-pipe pressure to the atmosphere. This sudden and full exhaust would move the pistons of the triple valves of the first cars the full stroke and thereby open the valves H to uncover the ports C in such valves.

However, in an action of this kind I think the pistons of the triple valves of the rear cars would not move their full stroke simultaneously with those of the first cars, owing to the fact that the pressure in the main air pipe would not be so quickly and fully exhausted at the rear end as at the front end. I have never tried this experiment on a train of 20 or 25 cars to see what would be the actual effect on the rear cars.

X 63 Q. I do not clearly understand from your answer whether or not you believe and assert that the operation recited in cross-question 61, would be performed by *all* of the several triple valves of a train of say 20 or 25 cars, under the conditions recited in cross-question 62.

To make the matter perfectly clear to the court and to me, please state whether or not, you believe and assert that said operation would be performed by *all* of said triple valves, under said conditions?

A. I have stated in my last preceding answer that I considered that only the valves on the first cars, say ten cars, would have the valves H opened to uncover the port C, therefore *all* of the valves

H would not fully uncover the port C, simultaneously with the front ones.

X 64 Q. Do you believe and assert that, under the conditions as recited in X Q. 61 and 62, the valves H of the triple valves of the cars at and towards the rear of the train, or succeeding those of, say the first ten cars, would be opened so as to uncover the ports C *at all?*

A. Yes, I believe the valves H would ultimately open the
875 ports C on all the cars, which opening would take place when the pressure in the main air pipe would be sufficiently exhausted.

Recess.

X 65 Q. It is the fact, is it not, that this ultimate opening of the ports C, by the valves H, of the triple valves on the cars at and towards the rear of the train, stated in your answer 64, wouid not, and *could* not, be effected, until the pressure in the main air pipe had been sufficiently reduced to become less than the equalized pressure in the auxiliary reservoirs and brake-cylinders of said cars at and towards the rear of the train?

A. It is a fact, to just what degree I am unable to state.

X 66 Q. Is it not the fact, unqualifiedly?

A. I should say it was on some of the cars.

X 67 Q. You mean by that, I suppose, on the cars at and towards the rear of the train, but cannot say on how many of said cars. Is this the fact?

A. Yes.

X 68 Q. And, it is, also, the fact, is it not, that this ultimate opening of the ports C by the valves H of the triple valves on the cars, at and towards the rear of the train, would not have any effect, whatever, in admitting air from the auxiliary reservoirs to the brake-cylinders through said ports C, for the reason that air had been already admitted from the auxiliary reservoirs to the brake-cylinders and the pressures in said auxiliary reservoirs and brake-cylinders had been equalized, as a necessary preliminary to the downward traverse of the pistons which effected the opening of the ports C by the valves H?

A. I should say it would be the fact on a train of the length of 25 cars.

X 69 Q. A train of 20 or 25 cars is not, and was not in 1879 a train of any extraordinary or unusual length in railroad service, was it?

876 A. No; and I think that at that time I would be safe in stating that there were very few, if any, freight cars equipped with air brakes to be used in freight service.

X 70 Q. There were, at that time, very many passenger cars equipped with air brakes to be used in passenger service, and, in many cases, these trains consisted of 8, 10 and 12 cars. I mean by passenger cars, cars used on passenger trains, including baggage, mail, express, dining and sleeping cars. Am I not substantially correct?

A. You are.

X 71 Q. From your description of the operation of the triple valves of patent No. 220,556, as given in answer 62, and from your succeeding answers, I understand you to admit that in a train of, say 20 or 25 cars, the operation of *admitting air* from the auxiliary reservoirs to the brake-cylinders by the opening of the valves H, so as to uncover the ports C, would be effected on the first cars of the train, and would *not* be effected on the cars at and towards the rear of the train. Is this correct?

A. Yes, that is my understanding of the matter.

X 72 Q. And this would, also, be substantially the case, would it not, on trains of a less length than 20 or 25 cars?

A. No, it would not on a train, say of 10 or 12 cars.

X 73 Q. Do you make this last statement as a matter of absolute and personal knowledge, or do you state it merely as a matter of opinion?

A. It is both; I have never tried it practically on a train, but I have tried it in the factory with about 10 brake-equipments connected as in practice, and the time it required to exhaust the main air-pipe pressure was such that I am satisfied that the triple valves on the last cars would be effected sufficiently great for the valve H to uncover the port C soon enough to admit the auxiliary reservoir pressure to the brake-cylinder through the port C.

X 74 Q. I got the idea from your preceding testimony that you never had more than *two* triple valves similar to the triple
877 valve of patent No. 220,556 at your factory or works. Am I right as to this?

A. Yes, you are right. The test I referred to in the preceding answer was made with valves manufactured by us.

X 75 Q. Were these triple valves that were manufactured by you similar to the triple valve of patent No. 220,556?

A. Yes, in the mode of operation, but the form was different. The valves I used were the same as defendants' quick-action triple valve, with the bushing 9 removed, so that they could not admit main air-pipe air to the brake-cylinder.

X 76 Q. Then, so far as triple valves, the same as the triple valve of patent No. 220,556 are concerned, if I understand you correctly, you never tried any experiment in operating them in connection with the brake-equipment of a train of 25 cars, 20 cars, 10 cars or any other number greater than two. Am I correct as to this?

A. You are.

X 77 Q. In such an operation of the triple valves of patent No. 220,556, as is recited in your answer 62 and in your subsequent answers, that is to say, in which air is admitted from the auxiliary reservoirs to the brake-cylinders, by the opening of the valves H so as to uncover the ports C, on the *first* cars of the train, and is *not* admitted from the auxiliary reservoirs to the brake-cylinders by the opening of the valves H, so as to uncover the ports C, on the cars at and towards the *rear* of the train, the result would be, would it not, to effect a comparatively quick and powerful application of the

brakes on the *first* cars, and a comparatively slow and light application of the brakes on the *rear* cars?

A. No, you are not entirely right according to my understanding.

The braking power or force applied would be alike on all the cars, but those on the first end would receive the power in a less space of time than the cars on the rear end of the train. This would be due to the brakes being applied to the cars on the
878 front end of the train by the valve H opening the port C, whereas those on the rear end of the train would be applied by the graduating valve, as the ports of the graduating valves are much smaller than the ports C uncovered by the main valves.

The brakes would be applied on both ends of the train by the full reservoir pressure, therefore the braking force will be the same.

X 78 Q. I, somehow or other, got the idea, from your testimony, that you held and asserted a theory to the effect that the triple valve of patent No. 220,556 and the triple valve of patent No. 360,070, for that matter, were devices, each of which had two different *designed* and *normal* functions, one being to effect a "partial" application of the brakes by the admission of reservoir pressure through the port controlled by the graduating valve, and the other, to effect a "full" application of the brakes through a port controlled by the slide-valve.

In view of your last preceding answer, in which you state that "the brakes will be applied on both ends of the train by the full reservoir pressure, therefore the breaking force will be the same," it seems to me that I must be mistaken.

Please state whether or not I am correct as to the view or theory I supposed you to hold?

A. You got exactly the theory I wish to convey, that the Westinghouse triple valve of patent No. 220,556 and the triple valve proper of complainants' patent No. 360,070 both performed normally the function of admitting auxiliary reservoir pressure to the brake-cylinder, 1st, by the graduating valve, and 2d, by the main valve (designated by the letter H in patent No. 220,556, and formed by the port 35 in the patent No. 360,070.)

You then asked the question, pertaining to a train of 25 cars, how the triple valve would act in this case which I answered, and, I believe, answered correctly; but the fact that the triple valve of patent No. 220,556 operated as I have stated on a train of 25 cars is no proof that it would not act on a short train of 5 or 10 cars, as I stated in my preceding answers.

879 X 79 Q. I still fail to reconcile your novel and ingenious theory as to the triple valves of patents Nos. 220,556 and 360,070 with your answer to cross-question 77.

You have admitted that the brakes would be applied on the *first* cars of a train such as we were talking about, as say 20 to 25 cars, by the admission of reservoir pressure to the brake-cylinders through the ports C controlled by the valves H, and that in the *rear* cars of the train the admission of reservoir pressure to the brake-cylinders

would *not* be effected by the opening of the ports C by the valves H. Under such conditions you say, in answer to X Q. 77, that "the brakes will be applied on both ends of the train by the full reservoir pressure, therefore the braking force will be the same."

Now if the braking force is the same when the reservoir pressure is admitted through the ports C, when opened by the valves H, and when the reservoir pressure is *not* admitted through said ports when opened by the valves H, but is admitted through the ports controlled by the graduating valves (e'), as in your stated operation of the train we have been talking about, will you please explain how, if at all, your theory of "full" and "partial" applications of the brakes applies, if your answer to X Q. 77 be correct, that is, if, as stated therein, "the same braking force" is exerted with the members of some of the triple valves in position for the "full" application of the brakes of your theory and with the members of some of the other triple valves in position for the "partial" application of the brakes of your theory?

A. It is true that the full reservoir pressure can be admitted to the brake-cylinders by either the graduating valve or through the ports C, when uncovered by the main valve H, the difference being that the air, when admitted to the brake-cylinder through the large port C, when uncovered by the valves H, would take a less space of time to equalize in the auxiliary reservoir and brake-cylinder than when passing through the small ports of the graduating
880 valve. Therefore the only difference in a 20 or 25 car train would be the time consumed in admitting the air from the auxiliary reservoir to the brake-cylinder by the two valves respectively when making a full application of the brakes. In case the brakes were to be applied gradually and partially the engineers' valve would be manipulated in such a manner that the graduating valves only throughout the 25 cars would be brought into action, thereby partially applying the brakes. Therefore this would be an illustration of the *partial* application of the brakes, in distinction to a *full* application of the brakes in as quick time as possible.

X 80 Q. If the only difference between the two applications of your theory be that of "time," as I understand from your last preceding answer, would not what you denominate the "full" and "partial" application, respectively, be more accurately designated as the "quick" application and the slower gradual application, inasmuch as you say that the "full reservoir pressure" will be applied on both ends of the train?

A. In considering the action as applied to a 20 or 25 car train, I should say it would be correct. My understanding of the graduating valve and its function is, that with the graduating valve the brakes can be more slowly applied, and the application of the brakes graduated to a nicety, as the case may require. Therefore, I drew the distinction between it and the main valve by terming its action a *partial* application of the brakes, whereas I defined the *full* application of the brakes by the main valve, as it, when brought into operation, would fully apply the brakes with the reservoir pressure in the quickest possible time.

Adjourned to Thursday, May 4th, 1893, at 10 o'clock a. m.

On Thursday, May 4th, 1893, at 10 o'clock a. m., same parties met, pursuant to adjournment, and proceeded as follows:

881 X 81 Q. In such an operation the triple valves of patent No. 220,556, as is recited in your answer 62, and in your subsequent answers, that is to say, in which air is admitted from the auxiliary reservoirs to the brake-cylinders, by the opening of the valves H so as to uncover the ports C, on the *first* cars of the train, and is *not* admitted from the auxiliary reservoirs to the brake-cylinders by the opening of the valves H, so as to uncover the ports C, on the cars at and towards the *rear* of the train, the result would be, would it not, to effect a comparatively quick application of the brakes on the *first* cars, and a comparatively slow application of the brakes on the *rear* cars?

A. Yes; that is my understanding of it.

X 82 Q. And that result would be a detrimental and injurious result as was demonstrated at the Burlington trials, most conclusively, by reason of the great shocks occasioned on the first cars of the train; am I not correct?

A. You are correct in regard to the fifty-car-train test; but my recollection is, that on the 25 car-train test the valves worked fairly satisfactory, although they would not work as well on a 25-car train as on a train, say, of about 10 cars.

X 83 Q. Regardless of the length of the train would not any operation of the triple valves in which the brakes were applied quickly to the *first* cars, and slowly to the *rear* cars, that is to say, in the manner as recited in your answer 62, be an objectionable, injurious and undesirable operation in practical railroad service?

A. I should say it would be on a train consisting of not less than 20 cars or more than 20. The longer the train the more serious the results would be, owing to the tardy action of the rear brakes which would permit the rear cars to butt the forward cars that had the brakes applied promptly. I should say, however on a train consisting of ten cars, such as are used in passenger service, there would be no serious or bad result.

My understanding is that the triple valve shewn in patent
882 No. 220,556 gave entire satisfaction in passenger service, and in such service the valves operated as I stated in my sixth answer. However, when these same valves were put in use in freight service on long trains, it was discovered that their action was entirely too slow on the rear of the train. Therefore while they were entirely satisfactory in passenger service they were not at all in freight service.

X 84 Q. I fully agree with you, and I do not see how any one familiar with air-brake practice could differ with you, that the greater the length of the train, the *worse* would be the result of a quick application of the brakes on the *first* cars, and a slow application of the brakes on the *rear* cars.

Now wholly regardless of the length of the train on which such an application was made, would not such an application be objectionable, injurious and undesirable in railroad practice?

BLEED THROUGH POOR COPY

A. On a train of more or less length you are correct.

X 85 Q. Would such an application of the brakes, in your opinion, be a proper, advantageous, desirable or correct one on a train of *any length?*

A. Theoretically it would not. Practically, so far as injurious results are concerned on a short train, say of 3, 4 or 5 cars, I don't think there would be any particularly bad results follow.

X 86 Q. Is such a mode of application of the brakes, that is to say, a quick application on the *first* cars and a slow application on the *rear* cars, believed by you to be correct and advisable practice, and are the triple valves manufactured by your company so organized as to effect such an application?

A. No, it is not a desirable practice, nor are the triple valves manufactured by us made to operate that way.

X 87 Q. Now, inasmuch as I understand you to admit that there is not a word of statement or suggestion in patent No. 220,556 that the triple valve of said patent operates to admit reservoir air to the brake-cylinder by the opening of the port C by the valve H; of your further admission that if so operating on a train of say
883 20 or 25 cars the brakes would be quickly applied on the *first* cars, and slowly applied on the *rear* cars, and of your further admission that on a train of more or less length such an application of the brakes would be objectionable, injurious and undesirable, I would like you to state to the court, if you can, what your reason is for assuming and stating as you have done, that the admission of reservoir pressure to the brake-cylinder by the opening of the port C by the slide-valve H, is a *normal* and *intended* function of the triple valve of patent No. 220,556?

A. This question assumes that I have admitted more than I did, that is to say, several of your preceding questions are in the abstract based on a theory that the valves *did* operate differently on the front and rear end of the train.

Counsel for complainant- interrupting the witness, calls his attention to his answer 62 in which he stated that they did so operate.

Witness continuing says: When I was interrupted by the counsel for the complainants, I was about to state that the valves would act different on a train, say, consisting of 25 cars, in which the brakes on the *first* cars would be applied with full force quicker than those on the *rear* end; but I did not admit that this would be the case in practice on a short train of, say, 5 or 10 cars, such as are used in passenger service. Now as the triple valves shewn in patent 220,556 were designed for passenger cars, and to be used on comparatively short trains, they worked satisfactorily when used as such. In this service of short trains the graduating valves would *normally* operate to admit the air from the auxiliary reservoir to the brake-cylinder when a graduated application of the brakes was desired, but when it was desired to fully apply the brakes as quickly as possible, then the slide-valves H would uncover the port C, and *they* would *normally* admit the auxiliary reservoir air to the brake-cylinder.

When these valves were put on freight cars to be used in
884 long trains it was discovered that the graduating valve (e') and the main valve H did not operate in their normal capacities as they did on short trains.

This l*ea*d to the invention of rapidly depleting the main air pipe of its pressure in order to make the graduating valve (e') and main valve H operate in their normal way. It is my opinion that this rapid depletion of the main air-pipe pressure was first suggested by Mr. George Westinghouse in 1879, as is shown by patent No. 217,838, dated July 22d, 1879; the object of this invention being to make the triple valve, shown in patent No. 220,556, operate in its *normal* way on long trains as it did and was intended to operate on short trains, and as explained by me in my 6th answer.

Objected to by counsel for complainants as being wholly irresponsive, and as being merely an unasked-for rambling argument as to the quick-action invention.

X 88 Q. Is this the best answer that you can or will make to the request of cross-question 87, that in view of your admissions therein stated you will give your reason for assuming something that is neither mentioned nor suggested in patent No. 220,556 to be a *normal* and *intended* function of the triple valve of said patent.

A. That is the best answer that I can give, as I believe the facts which I stated are true.

X 89 Q. In view of the opening clause of your answer to X Q. 87 I now ask you to indicate specifically to the court anything whatever in that question which assumes one iota more than you have distinctly and squarely admitted?

A. Your question 87 relates in part to a train of "more or less length," and then asks me to explain to the court how "the opening of the port C by the slide-valve H is a normal and inten led function of the triple valve of patent No. 220,556." Therefore, I think, you wish to imply that a train of more or less length includes a short train of, say from 5 to 10 cars, and that in a train of this kind the valve H would have no normal function. This is what I
885 meant when I said in my last answer to you, that your question "assumes that I had admitted more than I did."

Objected to by counsel for complainants as wholly irresponsive.

X 90 Q. Cross-question 89 asks you nothing whatever about what X Q. 87 "relates" to or what it "asks," but is strictly limited to what you say it "assumes."

Now, I again ask you to indicate specifically to the court anything whatever in X Q. 87 which assumes one iota more than you have distinctly and squarely admitted, and by this I mean I want you to quote to the court upon the record any portion of the language of X Q. 87 which you say or believe so "assumed."

A. The interpretation I put on the question was based on the assumed fact that the valve H, under no condition, would normally admit the auxiliary reservoir air to the brake-cylinder, and as this is *not* my understanding of the operation of the valve H I supposed

you wanted me to admit that such was not the fact. Therefore, my statement, in which I said you "assumed" certain things, was based on my interpretation of the question more than on the language you used.

Same objection.

X 91 Q. Will you, or will you not, quote to the court upon the record the portion of X Q. 87 which you think makes the "assumption" alleged by you in the first clause of your answer to that question?

A. As I before stated, I based the statement pertaining to what you "assume" *on my interpretation* of the question, and not on the language you used. Therefore, I am unable te quote any passages called for by your question to the supposed assumption.

X 92 Q. Now, will you not fairly and squarely say that in X Q. 87 I did not assume that you had admitted one iota more than you *did* admit?

A. Yes, I will; but I want it understood that when speaking of a train of more or less length it was in the abstract, and while discussing the matter of the action of the triple valves on a
886 train of more or less length the valves would operate differently on the front and rear of the train; but on a short train, such as a passenger train, the graduating valve would have a normal action and also the main valve would have a normal action.

X 93 Q. You say in answer 87 "that the triple valves of patent No. 220,556 were designed for passenger cars and to be used on comparatively short trains." Do you find any warrant in the patent for this statement, and, if so, where?

A. No; I do not.

X 94 Q. Have you any actual and personal knowledge that in actual practice in railroad service the triple valves of patent No. 220,556 were normally operated to admit reservoir pressure to the brake-cylinder by the opening of the port C by the valve H. If so, how, when and where was such knowledge acquired?

A. What practical knowledge I have of the triple valve shown in the patent No. 220,556 consists, principally, of the knowledge I gained of its action when I was experimenting with the triple valve used by us on the B. and O. railroad. In some of these experiments we would connect cars equipped with the Westinghouse brake, which equipment contained valves like those shown in patent No. 220,556, in order to see how our brakes would work with the Westinghouse. In these tests I noticed that when the air would be intermittingly discharged by the engineer's valve that the brakes would gradually and partially apply, but if the pressure from the main air pipe was rapidly discharged by the engineer's valve the brakes would more quickly apply than when using the graduating valve. I have, also, at our factory made numerous experiments with the Westinghouse triple valve, as shown in patent No. 220,556, in which I always found the Westinghouse triple valve shown in the patent No. 220,556 to operate as I have stated in my answer 6.

X 95 Q. In these experiments at your factory, I understand from your previous testimony, that you only used two triple valves like that shown in patent 220,556? Is that correct?

887 A. Yes.

X 96 Q. Were the experiments and tests on the B. and O. railroad which you have referred to in answer 94 conducted by you or under your direction?

A. They were.

X 97 Q. Were they made in the ordinary running of the train in regular service or was the train merely put at your disposition by the B. and O. officers for experimental purposes, and used by you experimentally only?

A. The train was first put at my service for experimental purposes, and it was then that I made the experiments mentioned, although it was put in regular service afterwards, and I would frequently travel with it, but it was not then under my control.

Recess.

X 98 Q. How many triple valves like that of patent No. 220,556 were used on the B. and O. train during your experimental use thereof, and do you know, from personal examination, that all of these triple valves *were* similar to that of patent No. 220,556?

A. My recollection is that there were about two or three cars with the Westinghouse brake on them in the train. I personally examamined the valves on the outside only; I did not take them apart.

X 99 Q. You are not able to say, then, of your own knowledge that the two or three Westinghouse triple valves used on this experimental train were constructed the same as the triple valve of patent No. 220,556?

A. My judgment was based on the outside form of the valve casing, which conformed exactly to those I had in our factory, and which I made the experiments with there. Therefore, I am satisfied they were the same as shown in patent No. 220,556.

Answer objected to by complainants' counsel as not responsive.

X 100 Q. X Question 99 repeated.

A. I did not take the valve apart to examine it.

888 X 101 Q. That being the case, you, therefore, do *not* know, of your own knowledge, that these two or three Westinghouse triple valves were constructed the same as the triple valve of patent No. 220,556? Is this the fact?

A. While I did not take the valves apart to examine them, I am satisfied they were the same from their outside form.

Objected to by complainants' counsel as not responsive.

X 102 Q. Do you or not know, of your own knowledge, whether the two or three Westinghouse triple valves of the B. and O. railroad experimental train were constructed the same as the triple valve of patent No. 220,556?

You will save unnecessary delay in cross-examination if you will refrain from repeating your conjectures, ideas, or belief about these

valves, and will simply give what is asked for, namely, a statement of your own knowledge about them.

Objected to by counsel for defendant- as useless and vexatious repetition of a question already fully answered by the witness fully stating the facts to the court. The present question is apparently based on the incorrect assumption that there is only one source of human knowledge, and that is through the eye.

Counsel for complainants replies, that while it is perfectly competent for the witness, being an expert, to give statements of opinion when asked for, that capability does not excuse him from answering questions as to *facts* when relevant to his examination-in-chief. It may be that the *belief* of the witness is perfectly correct, but he is not asked as to his belief, but as to his personal knowledge, and counsel for complainants is unable to understand why he evades a direct answer, and knows of no rule of evidence which would excuse or justify such evasion.

889 A. I have stated that I did not take the valve apart to ascertain if they were made *just* like the valve shown in patent No. 220,556, but the exterior form was the same as that shown in patent No. 220,556; and the operation of the valve in applying the brakes by graduating application and quick and full application, leave no doubt in my mind but that the valve was the same as shown in the patent No. 220,556.

Objected to by counsel for complainants as wholly irresponsive, and counsel for complainants protests against the persistent evasion of the witness in giving statements of his *belief* when he has been told that his belief was not asked for and that he is interrogated only as to his own personal knowledge.

X 103 Q. X Q. 102 repeated.

A. I know they were the same, as near as a human being can know that a thing is so.

X 104 Q. Am I to understand from that that you answer X Q. 102 in the affirmative?

A. My understanding is that the valves used were the same as those shown in patent No. 220,556.

Answer objected to as wholly irresponsive by counsel for complainants.

X 105 Q. X Q. 104 repeated.

A. As I have stated, the valves were the same. I have given the reasons why I know they were the same, and this is the best answer I can make to the question.

Answer objected to by counsel for complainants as wholly irresponsive.

X 106 Q. To save further waste of time, please answer X Q. 102 in the affirmative or the negative, as you choose, or say that you refuse to do so?

A. I have stated that I know the valves used in the experiment were the same, by their exterior form and by their operation. If

the question means that every part should be just the same *in every particular of construction,* then I cannot say whether they were or not.

X 107 Q. While the practice of identifying a valve mech-
890 anism having its ports and moving members in a closed case with a structure described and shown in a patent by the exterior form of the device appears to me to be very remarkable on the part of a mechanical engineer, it is possible that you may have supplemented your exterior examination of the two or three Westinghouse triple valves of the B. and O. experimental train by making some outside measurements of said triple valves and comparing such measurements with corresponding measurements of the Westinghouse triple valves which you had at your works? Did you go so far as to do this?

A. I did not take any measurements or make any comparison by measurements.

X 108 Q. Do you understand that the "freight-brake triple valve" shown in plate B 25 of the Westinghouse 1886 catalogue performs the function which you have ascribed to the triple valve of patent 220,556, *i. e.*, that of admitting reservoir pressure to the brake-cylinder through a port corresponding to the port C of patent 220,556 by the uncovering of such port by a valve corresponding to the valve H of such patent?

A. I have never had any experience with a valve made just like the one you have referred to. My opinion is, however, judging from the proportions shown in the cut, the slide-valve therein represented would not uncover the port C as in patent 220,556.

X 109 Q. This "freight-brake triple valve," plate B 25, substantially the same operative combination of piston slide-valve carried by the piston stem, graduating valve, controlling port in the slide-valve and port in the valve casing with which the port of the graduating valve is brought into communication by the piston and slide-valve, as is found in patent 220,556. Is not this, in all material and substantial particulars the case?

A. My understanding is that the operative combination is not the same. The valve shown in plate B 25, as I understand it, is so arranged that the graduating valve only will admit the auxiliary pressure to the brake-cylinder; whereas, in patent 220,556
891 the graduating valve admits the auxiliary reservoir air to the brake-cylinder by the first movement of the piston, and, in addition, the valve H will admit the auxiliary reservoir air to the brake-cylinder, when it uncovers the port C by the final movement of the piston.

X 110 Q. Please specify, referring to each member separately, in what particular or particulars, if any, which you suppose the combination of members recited by me in the last preceding question differs in any material or substantial particular from the combination of the corresponding members in the triple valve of patent 220,556.

Adjourned to Friday, May 5th, 1893, at 10 o'clock a. m.

10 A. M., FRIDAY, *May 5th*, 1893.

Met pursuant to adjournment.

Parties present as before.

Cross-examination of GEORGE A. BOYDEN resumed:

A. My opinion is that the parts are all the same except the cylinder B of the cut or plate B 25. The cylinder in the device shown on plate B 25 is shorter than that of the one shown in patent 220,556. The effect of this short cylinder is to prevent the slide-valve from uncovering the port leading to the brake-cylinder, thereby destroying the function of admitting air to the brake-cylinder by the valve H, as used in patent 220,556. With this exception, my opinion is the other parts are substantially the same.

X 111 Q. Now, the only difference you indicate between the triple valve of patent 220,556 and that of plate B 25 which you think at all substantial, being that the piston cylinder in plate B 25 is shorter than that in the patent, I ask you, in view of your admitted familiarity with letters patent for inventions, whether you
892 do not think that the triple valve of plate B 25 corresponds in all particulars described and claimed in patent 220,556 (except so far as to the small port S 2 in the slide-valve, which I do not understand to bear upon the present question,) with said triple valve of patent 220,556?

A. I stated in my preceding answer that the difference was not only the short cylinder, but that the slide-valve would not uncover the port leading to the brake-cylinder; therefore, my understanding is that the difference between the two is not only the short cylinder, but the function of one valve is destroyed (that of the slide-valve uncovering the port leading to the brake-cylinder). This I consider a substantial difference.

X 112 Q. I think you have omitted to notice that X Q. 111 asked as to the correspondence "in all particulars described and claimed in patent 220,556." Now, as I do not understand either from said patent or from your preceding testimony, that the function that you refer to or any means for accomplishing it, is either described or claimed in patent 220,556, I will repeat X Q. 111, asking you to answer it simply as to matters described and claimed.

A. As I have stated in several of my previous answers that I considered patent 220,556 was for a valve device in which the air could be admitted from the auxiliary reservoir to the brake-cylinder by either the grad-ating valve (e') or by the slide-valve H uncovering the port C, and I still maintain this to be a fact, as the drawings in patent 220,556 described such a valve device. Therefore, my understanding is that the valve device shown in plate B 25 is not the same as the valve shown in patent 220,556, because, as I have before stated, the air from the auxiliary reservoir is only admitted through the port controlled by the graduating valve to the brake-cylinder in the device shown in plate B 25; whereas, in the patent 220,556 the auxiliary reservoir air is admitted to the brake-cylinder by either the graduating valve or by the slide-valve H uncovering the port in the brake-cylinder.

893 While I do not find any exact language in patent 220,556 setting forth that the valve H operates to admit the air from the auxiliary reservoir to the brake-cylinder by uncovering the port C, yet it is obvious that such is the case, as the patent specification refers to previous patents issued to George Westinghouse, and I will now quote those paragraphs which pertain to the prior state of the art:

"In the class of fluid-pressure brakes for railway trains, commonly known in this country as automatic brakes, a device usually termed a triple valve is extensively used. This device, in two of the many forms in which it has been patented, is shown and described in United States patents granted to me October 5, 1875, No. 168,359, and January 11, 1876, No. 172,064, as well as in various other earlier and later patents.

"It is important in such device that the valve (lettered H in said two patents and herein) which governs the flow of air or other fluid shall move not only with great certainty to any desired position, but shall move with slight variations of pressure on the piston (lettered G), so that the application of the brakes with any desired power and their ready release may be quickly and easily effected at the pleasure of the engineer.

"To this end I combine with the said valve H, giving it a slight range of motion on its stem, an auxiliary valve operated by the same stem, in such manner that a *portion of the functions performed in said patents by the valve H may now be performed by such auxiliary valve.*" (The use of the italics is my own.)

A. (continued). I have before stated that the specifications of patent No 220,556 did not directly state that the valve H admitted the air from the auxiliary reservoir to the brake-cylinder by uncovering the port C; but, if considered with drawing of patent 220,556, the portions of the specifications I have quoted and with the patents cited in the quotation it is perfectly obvious that the valve may uncover the port C leading to the brake-cylinder, and thereby
894 admit auxiliary reservoir air to the same. Therefore, my understanding is that the device shown in plate B 25 is not the same as the device shown in patent 220,556, inasmuch as it fails to perform one of the functions of patent 220,556.

It is true that the elements are all the same and the number of parts the same, but the fact that the cylinder is made shorter, and thereby destroying the function of admitting auxiliary reservoir air to the brake-cylinder by the valve H uncovering the port C, makes the two different.

The mechanical combination is the same in both devices, but the mode of operation is different. Therefore, as I understand patent matters, this makes them different devices.

X 113 Q. Briefly stated, then, the only structural difference which you find between the triple valve of plate B 25 and that of patent 220,556 pertinent to X Q. 111 is that in the former the cylinder and the stroke of the slide-valve are shorter than in the latter, and the only operative or functional difference which you allege is that in the former reservoir pressure can only be admitted through the port

BLEED THROUGH POOR COPY

controlled by the graduating valve, while in the latter it may either be admitted through the port controlled by the graduating valve or through the port C when uncovered by the valve H. Am I correct in this?

A. That is my understanding of the matter.

X 114 Q. There is nothing in the specification of patent 220,556, is there, which prescribes any length of stroke of the slide-valve as essential to the operation of the device or as being any part of the invention described and claimed?

A. As I understand it, there is not, except indirectly.

X 115 Q. Where, in the specification, either directly or indirectly?

A. As the specification states that "*a portion*" of the functions performed in said patents (168,359 and 172,064) "by the valve H may now be performed by such auxiliary valve" (valve e')

895 in connection with this quotation and the drawing, which I understand is part of the specification of the patent, my opinion is that the stroke of the piston may be read from the patent.

X 116 Q. The essential difference between the triple valves of the prior patents referred to and that of patent 220,556 is that in the former the admission and regulation of the degree of admission of reservoir pressure to the brake-cylinder through the port C could only be effected by movements of the slide-valve, the upper end of which opened to a greater or less degree, and closed as required said port C, while in letters patent 220,556, such admission being controlled by a separate graduating valve, movements of the slide-valve and the attendant friction due thereto were obviated. Is not this substantially the case?

A. My understanding is that you are partly correct; but, in order to first apply the brakes the friction of the slide-valve has to be overcome in all three devices. After this is accomplished, however, the graduating valve in patent 220,556 will open and close to admit air to the brake-cylinder without necessarily moving the slide-valve; but if it is desired to open the slide-valve it can be done by giving the piston its full stroke. In this last case the device shown in patent 220,556 would operate like the slide-valve in the earlier patents mentioned; that is to say, the slide-valve H would then uncover the port C and admit auxiliary reservoir air to the brake-cylinder.

X 117 Q. In view of the utter absence from the specification of patent 220,556 of any description of such an operation as would uncover the port C by the slide-valve H, and in view of the analogy in other respects of the structure described and shown in that patent with those shown in the drawings of the prior patents, do you consider it in the least degree an unreasonable assumption that the inventor simply took the structures of the prior patents as the basis for the drawings of the present one, with his graduating-valve improvement, and disregarded the fact that with the length of

896 cylinder shown the possibility of such a superfluous and unmentioned traverse of the slide-valve existed?

Objected to as incompetent in attempting to vary the plain meaning of the description in the specification of patent No. 220,556 by oral evidence; and, also, as assuming that the function performed by the slide-valve H of uncovering the port C by the full stroke of the piston is superfluous.

Counsel for complainants submits that inasmuch as the witness has interjected in the specification of patent 220,556 an alleged function which he admits is not therein recited it is not reasonable to consider the statement of such interjection as "*superfluous*" as being an "*assumption*," and also submits that it is entirely competent to cross-examine him in any manner tending to elicit his warrant for such interjection.

Defendants' counsel replies that Mr. Westinghouse "interjected" into his patent No. 220,556 the main valve of his two former patents, and his counsel is now endeavoring, by oral evidence, to withdraw or eject from patent 220,556 the matter so placed in it by Mr. Westinghouse; and it is for this reason that the objection of defendants' counsel is made.

Counsel for complainants submits to the court that the question of whether or not the witness has interjected anything into the specification can be better and more properly determined by the court from a comparison of the specification with the witness' testimony than from the statements of counsel.

A. My understanding of the matter is that when Mr. Westinghouse took out his patent 220,556 he had in view to provide an auxiliary valve to the main valve H, in order that the auxiliary valve would perform "a portion" of the work previously done by the main valve, but in a more delicate manner, at the same time preserving all the former functions of the main valve H, and
897 I think I am correct in this view from the fact that the valves
manufactured under patent 220,556 are made in exact accord with the drawings of the patent 220,556; therefore, I do not think "*the inventor simply took the structure of his prior patents as the basis*" from which to make his drawings in patent 220,556.

X 118 Q. And you think, do you, that when he published his invention of patent No. 220,556 by the issue of said patent he designed and intended the public to believe that it was to be operated so as to open the port C by the main valve H in applying the brakes?

Objected to upon same grounds as X Q. 117.

A. I can't say what he *intended* to imply, but I do know that the Westinghouse Company made valves under patent 220,556 that would operate so as to open the port C by the slide-valve H, and I closely examined one of the valves this morning, and found that the graduating valve would admit the auxiliary reservoir air to the brake-cylinder by the first partial stroke of the piston, and that the auxiliary reservoir air would be admitted to the brake-cylinder by the main valve H uncovering the port C by the final portion or the full stroke of the piston.

X 119 Q. Inasmuch as the operation of triple valves like those shown in the drawings of patent 220,556 in such manner as to uncover the ports C by the valve H would, as you have correctly admitted in your preceding testimony, produce an objectionable, injurious and undesirable result on a train of more or less length, do you not think that such an operation of said triple valve would be a *misuse* and abuse of them, instead of a proper and normal operation of them?

Same objection.

A. When we were talking about a train of "more or less length" my understanding was that such a train would consist of say twenty-five cars, and on a train of this length it is likely there would be more or less injurious results; at least, that is my opinion; but when the valve device shown in patent 220,556 was used on a passenger train consisting, say of from five to ten cars, then
898 I do not think there would be any serious practical objections, and, inasmuch as these valves were used on passenger trains for a number of years, and on nearly all the railroads in the United States, and gave entire satisfaction (to the best of my information), I think it is wholly obvious that by uncovering the port C by the valve H to apply the brakes, such an operation would *not* be a misuse or abuse of the valve device.

1 p. m. recess.

X 120 Q. In the use of these triple valves of patent 220,556 for a number of years, and on nearly all the railroads in the United States, do you know, of your own knowledge, and do you state as of your own knowledge that said triple valves were operated in practice, and that such operation was approved and permitted by railroad officials in such manner as to uncover the ports C by the slide-valves H of the triple valves in effecting the application of the brakes?

A. I never practically operated the brakes in regular service, but my understanding has always been that the valves were to be operated as I have stated, that is to say, if it was desired to gradually and partially apply the pressure, the engineer's valve would be manipulated to operate the graduating valve, but in case the brakes were to be applied fully, as in the case of an accident, then the engineer's valve would be placed in a position to fully discharge the main air-pipe pressure, which would uncover the ports C by the movement of the slide-valve, and thereby apply the brakes in the quickest possible time. This operation has been explained to me by several engineers that have handled the Westinghouse brake for a great many years; and from the fact that the Westinghouse 1886 catalogue, page 10, states this operation to be the one used in operating the triple valve shown in patent 220,556, I think my conclusions as to its operation are correct. Other than this, with
899 the exception of the experiment I made, as stated in my previous answers, I have had no practical knowledge of the working of the device.

So much of the foregoing answer as relates to the understandin belief or conclusions of the witness, or to hearsay statements other persons, objected to as irrelevant, immaterial and not r sponsive.

X 121 Q. If I understand your last preceding answer correctl you do *not* know of your own knowledge, and do *not* state as your own knowledge, that in the use of these triple valves of pate 220,556 for a number of years, and on nearly all the railroads the United States, that said triple valves were operated in practic and that such operation was approved and permitted by railroa officials, in such manner as to uncover the ports C by the slid valve H of the triple valves in effecting the application of th brakes. Am I correct?

A. I do not know whether the railroad officials permitted th operation of the triple valve so as to uncover the ports C by th slide-valve, but I do know, from my shop experiment, that if suff cient air was discharged from the main air pipe the valve H *woul* uncover the port C and apply the brakes by the uncovering of sai port. As to the actual working of the valve in practice, my ex perience consisted, as I have before stated, with the experimenta train on the B. and O. railroad, so far as the operation of the valv shown in patent 220,556 is concerned.

Objected to by counsel for complainants as not responsive.

X 122 Q. X Q. 121 repeated, the attention of the witness bein called to the fact that it does not ask anything about the witnes shop experiment nor his experiment with a few Westinghous triple valves on the B. and O. experimental train, but is strictl and in terms limited to his own knowledge as to the operation o the triple valve of patent 220,556 in their use for a number o years and on nearly all the railroads of the United States.

900 A. As I have stated substantially in several of my pre ceding answers, the only experience I have had is that which I stated, which simply is that I never ran a train equipped with the Westinghouse brake as an engineer or in any capacity; there fore, never had any practical experience in the operation of the brake on trains in practice.

Same objection.

X 123 Q. You cannot then state, and do not state, of your own knowledge that in actual railroad practice the triple valves of patent 220,556 were so operated by the engineer as to uncover the ports C by the valves H in effecting the application of the brakes. Am I correct?

A. You are as to just how engineers did operate the brake.

X 124 Q. Please state the maximum length of train, equipped with triple valves like those of patent 220,556, in which you suppose an application of the brakes by uncovering the port C by the valves H could be made without effecting a quick application of the brakes on the first cars of the train and a slower gradual application on the rear cars of the train?

A. I have never made any experiments on a train in actual practice to determine just where the main valves would cease to open port C. My opinion is, based on shop experience, that it would be from five to ten cars from the front end of the train.

X 125 Q. You give, then, ten cars as the maximum length of train on which you think this operation could be effected without applying the brakes quickly on the front cars and slowly or gradually on the rear cars. Is this correct?

A. That is about my opinion in the matter.

X 126 Q. I understood from your preceding answers that this could be done on a train of anything less than say twenty or twenty-five cars. Did I misunderstand your previous testimony or has a fuller consideration since led you to modify your views?

A. Please point out what answers you refer to.

901 Counsel for complainants states that he does not understand that he is under any obligation to refer the witness to his specific answers of his preceding testimony, which convey the understanding recited in the last preceding question, and that to hunt them up would involve some little delay, particularly as a part of the preceding testimony, which is in manuscript, is now out of the room and in the hands of the copyist. Counsel will, however, take the time to look them up if the witness so desires and requests, but thinks that he ought to be able to answer the questions without causing the delay necessary to do this.

WITNESS: I do not recall just the questions you refer to, as I think in my preceding testimony I have stated that ten cars or twelve cars would be the maximum length.

Counsel for complainants states that to avoid delay, he will not press the question further, but will elicit the substantial points involved in complainants' testimony in reply.

X 127 Q. As a mechanical engineer, familiar with letters patent, you will, I presume, admit without hesitation that there is nothing whatever in patent 220,556 which prescribes any particular relative proportions of the port C and of the port *c* which is controlled by the graduating valve. Will you make such admission?

A. No, I will not, as I find on page 2 of the printed specification that the size of the port *s'* is three-sixteenths of an inch in diameter. Now, taking this as the basis of measurement, and comparing it with the drawing, I find that the port C is about twice the diameter of the port *s'*; therefore, as a mechanical engineer, if I was handed the patent 220,556, with the request to design a valve like that shown in the said patent, I would undoubtedly make the port C about twice the diameter of the port *s'*; however, I find nothing in the printed part of the specification which gives relative measurements.

902 X 128 Q. Now, don't you know very well that the citation from the specification which you have made has nothing whatever to do with the relative proportions of the port, *s'*, controlled by the graduating valve and of the port C, respectively, and,

on the other hand, *does* relate specifically to a comparison of said port s' with another and smaller port s'', which in the same sentence is stated as five sixty-fourths of an inch ?

A. It is true the comparison as drawn in the specification pertains to the ports s' and ss'' ; but, as a mechanical engineer, I have taken one of those measurements in order to get a size of one port; having acquired this size, I used it as a basis to compare the size of the port s' and the port C, and by such comparison I found the port C to be about five-sixteenths to three-eighths in diameter, and which I think is very near correct as the valve is made in practice.

X 129 Q. Was the citation which you made from the specification in your answer 127 as to the diameter given for the port s', when comparing it with the port s'', necessary in the slightest degree to enable a mechanical engineer or anybody else to discover the perfectly obvious fact that as shown in the drawings, "the port C is about twice the diameter of the port s'," or, in other words, would not you or I or anybody else, on inspection, ascertain that the relative diameters of the ports s' and C are as shown in the drawings about as you have stated, just as well without the specification's comparison of the ports s' and s'' as with it ?

A. Yes, it would be perfectly obvious that the port C was about twice the diameter of the port s', but in order to get an idea of the size of the ports in figures, I used those in the specification as the basis.

X 130 Q. Now, coming back to the inquiry of X Q 127, which did not ask anything about the port s'', I wish you would indicate any portion of the specification which sets forth the comparative diameters of the port s' and of the port C, respectively, or which says or in the remotest degree intimates that the port s' should be or must be, or, in order to perform the normal functions
903 of the device, is made in the slightest degree smaller than the port C ?

A. I do not find in the printed specification any statement relative to the comparative size of the port s' with the port C, but the drawing, which is just as important a part of the patent as the printed specification, plainly shows that the port C is twice the diameter of the port s', and I am satisfied that the proportions shown in the drawing are substantially correct, as not later than this morning I examined one of the Westinghouse valves made under patent 220,556, with the view to ascertain the size of the port, and I found s' to be about three-sixteenths of an inch in diameter, and the port C about five-sixteenths in diameter, as near as I could measure it.

All of the last preceding answer subsequent to "port C" in the first clause thereof, objected to as not responsive and as a mere volunteer statement.

X 131 Q. Are you in the habit, when considering letters patent, of assuming that the drawings thereof are to be treated as working drawings, and that the dimensions therein are to be followed as of

the essence of the invention in cases where the specification neither states nor intimates such to be the fact?

A. I am in the habit of following the proportions of the drawings shown in patents whenever I am satisfied that the drawing is made to a scale and made from the actual device it is to represent.

X 132 Q. Coming down from the abstract to the concrete, am I to understand that you believe and state that the relative proportions of the ports *s'* and C, which happen to be shown in the drawings of patent 220,556, are of the essence of the invention, and must be followed in view of your admission that there is nothing in the specification to that effect?

A. My opinion is that the relative size of the ports *s'* and C are not the essence of the invention set forth in patent 220,556, as the essence of that invention is combining an auxiliary or grad-
904 uating valve *e'* with the main valve H, in order that it (valve *e'*) may perform a portion of the work of the slide-valve H.

X 133 Q. In view of your last preceding answer, I presume that you will not hesitate to admit that the relative sizes of the ports *s'* and C, not being of the essence of the invention set forth in patent 220,556, it would be perfectly competent for the constructor of the triple valve to make the port *s'* as large as the port C, and that under such circumstances the triple valve would embody the invention described and claimed in said patent and be just as fully within the claims thereof as if made with the port *s'*, *half* the diameter of the port C as shown. Will you make this admission?

A. Pertaining to its coming *within the claims* of patent No. 220,556, I should say you are right; but, as a constructor of a triple valve, I should make the proportions of the ports about the same as are shown in the drawing of the patent.

X 134 Q. If the port *s'* were made as large as the port C, would not the triple valve perform every function recited in patent 220,556?

Objected to as immaterial and irrelevant.

A. I should say it would to a degree.

X 135 Q. If the port *s'* were made as large as the port C, would not just as quick and just as full an application of the brakes be effected through the port *s'* into the port C as if the device performed your supposed function of admitting reservoir pressure to the port C by uncovering said port by the valve H?

A. That would depend wholly on how the engineer's valve was manipulated.

X 136 Q. If the port *s'* were made as large as the port C, and brought into register with the port C by such manipulation of the engineer's valve as was known and practiced in railroad service in 1879, would not just as quick and just as full an application of the brakes be effected through the port *s'* into the port C, as if the device performed your supposed function of admitting reservoir pressure to the port C by uncovering said port by the valve H?

905 A. My opinion is that if ports *s'* and C were made the same size, and they were placed coincident with each other, and

the graduating valve would remain open, and the main valve H remain in position as stated, that the air then would pass from the auxiliary reservoir to the brake cylinder through the said ports equally as quick as though the slide-valve H had uncovered the port C.

4.20 p. m.—Adjourned until Saturday, April 6, 1893, at 10 o'clock a. m.

10 A. M., SATURDAY, *May 6th*, 1893.

Met pursuant to adjournment.
Parties present as before.

X 137 Q. Your opinion that the admission of auxiliary reservoir pressure to the brake-cylinder, through a port controlled by the slide-valve, to effect an application of the brakes (as distinguished from the admission of auxiliary reservoir pressure to the brake-cylinder, through a port controlled by the graduating valve, to effect an application of the brakes), is a normal and intended function of the triple valves of patents 220,556 and 360,070, is based upon your view that a quicker application of the brakes is or may be effected through a larger opening, in the first case, than through a smaller one in the second, and that, in said patents, a larger port opening is effected in the first case than in the second. Am I correct?

A. You are partly correct pertaining to patent 220,556; but as to patent 360,070, I do not understand that in the device shown in patent 360,070 that the admission of air from the auxiliary reservoir to the brake-cylinder is therein admitted quicker by the slide-valve than by the graduating valve.

X 138 Q. It is your opinion, is it not, that the admission of auxiliary reservoir air to the brake-cylinder by the slide-valve, and the admission of auxiliary reservoir air to the brake-cylinder by
906 the graduating valve are normal functions in both patents 220,556 and 360,070?

A. It is.

X 139 Q. Is the supposed normal function of the admission of auxiliary reservoir air to the brake-cylinder by the slide-valve in patent 360,070, which you have alleged, a function similar in operation and result to the alleged normal function of admission of auxiliary reservoir to the brake-cylinder by the slide-valve in patent 220,556, or is it a different function?

A. It is the same function, inasmuch as in both patents the auxiliary reservoir air is admitted to the brake-cylinder by the corresponding action of the two slide-valves, which action is due to the final movement of the piston in making the full stroke. It is true, however, that in patent 220,556 the auxiliary reservoir air is admitted to the brake-cylinder *much faster* by the opening of the slide-valve than by the opening of the corresponding valve 35 in patent 360,070. This difference is made because in patent 220,556 there is no means provided to quicken the action of the brake other than by the quick admission of the auxiliary reservoir air to the brake-cylinder by the opening of the large port C by the slide-valve; whereas, in patent 360,070 provision is made to quicken the applica-

BLEED THROUGH POOR COPY

tion of the brake by admitting main air-pipe pressure to the brake-cylinder by another valve (41), therefore, in patent 360,070 it is not necessary to admit the auxiliary reservoir air as rapidly to the brake-cylinder as in patent 220,556.

X 140 Q. You say that "it is the same function." Is it the same function in *result* in both patents 220,556 and 360,070?

A. It is, except as to time required.

X 141 Q. I understand you to allege that the result of the supposed function of effecting an application of the brake by the opening of the port C by the valve H in patent 220,556 is to effect a *quicker* application than would be made by the opening of the port controlled by the graduating valve c' in said patent.

Am I correct?

907 A. That is my understanding of the device shown in patent 220,556.

X 142 Q. Is the result of opening the port 35 in the slide-valve to the brake-cylinder in patent 360,070 to effect a *quicker* application of the brake than would be made by opening the port controlled by the graduating valve in said patent?

A. My understanding is that it is not, for the reason that in the device shown in patent 360,070 it is not necessary to admit the auxiliary air to the brake-cylinder as rapidly as in patent 220,556, because there is an auxiliary valve arranged with the triple valve in patent 360,070 to produce the quick application of the brake.

X 143 Q. Such being the case, what, if any, different function or result would be performed in the operation of the triple valve of patent 360,070 if actuated in the manner you allege that it is in answer 6, (to wit: "To apply the brakes fully with the auxiliary reservoir pressure by the final movement of the piston 12, a sufficient amount of air is gradually exhausted from the main air-pipe to move the piston its full stroke.") than is performed in the operation of said triple valve, if actuated to admit air to the brake-cylinder through the port controlled by the graduating valve 29, as in your function "2nd" of answer 6?

A. As to the time required for the admission of auxiliary reservoir air to the brake-cylinder by either the graduating valve 29 or the valve formed by the port 35 my opinion is there would be no difference in patent 360,070. In my answer 6 I defined the functions of the graduating valve 29 as being produced by the preliminary movement of the piston 12, and defined the function of the valve formed by the port 35 as being produced by the final or full movement of the piston 12.

Answer objected to by counsel for complainants as wholly irresponsive.

X 144 Q. X Q. 143 repeated; the attention of witness being directed to the perfectly plain terms in which it asks him for a statement of the difference of *function* or *result*, if any.

908 A. My opinion is, as to function or result, there would be no difference; but in the action of the devices the graduating valve would open and close and intermittingly admit the auxiliary

reservoir air to the brake-cylinder; whereas, if the auxiliary reservoir air was admitted to the brake-cylinder through the port 35 it would flow continuously.

X 145 Q. You say in answer 6 "to apply the brakes fully with the auxiliary reservoir pressure, by the final movement of the piston 12, a sufficient amount of air is gradually exhausted from the main air pipe to move the piston its full stroke. This will bring the valve port 35 coincident with the passage 22, and thereby establish communication from the auxiliary reservoir to the brake-cylinder, and fully apply the brake with the reservoir pressure."

This is a fuller and more detailed description, is it not, of what you call, in your answer 6, function "3rd" of the "valve mechanism," to wit: "3rd, to admit auxiliary reservoir air to the brake-cylinder through the valve port 35 by the final movement of the piston?"

A. It is.

Adjourned to meet at same place at 9.30 o'clock a. m., Monday, May 8th, 1893.

MONDAY, *May 8th*, 1893—9.30 a. m.

Met pursuant to adjournment.

Parties present as before.

X 146 Q. There being, as you have admitted in answer 144, no difference in *function* or *result*, between the operation of the triple valve of patent 360,070, if actuated in the manner described by you in answer 6, to perform its alleged "3rd" function, and its operation when actuated to perform its "2nd" function (of said answer 6), you will now admit, will you not, that in order to accord and agree with the *actual* and *practical* operation of the Westinghouse
909 quick-action triple valve of patent 360,070 (as well as with its *normal* and *intended* operation, as described between line 80, page 3, and line 51, page 4 of the patent) your recital, in answer 6, of its "1st, "2nd," "3rd" and "4th" *functions* should be amended substantially as follows:

(*a*) By striking out function "3rd."

(*b*) By changing the enumeration of function "4th" to "3rd."

(*c*) By reciting as the "4th" function: "4th, to apply the brakes with great rapidity and with their greatest available force, by admitting air directly from the main air pipe to the brake-cylinder."

A. I do not admit that I was wrong in my description of functions "1st," "2nd," "3rd" and "4th," as stated in my answer 6, as in that part of my answer 6 I was describing the valves that formed the triple valve proper, and I feel that such description was correct, inasmuch as the specification of patent 360,070, lines 105 to 118, describes the function of the graduating valve as follows: "The movement of the slide-valve 14 then closes the port 23, preventing escape of air from the brake-cylinder, and places the passage 31 partly or wholly in communication with port 33. *The small auxiliary valve 29 having been meanwhile unseated by the movement of the piston stem, compressed air from the auxiliary reservoir passes through the lateral port 32 and passage 31 of the slide-valve 14 and the passages*

BLEED THROUGH POOR COPY

22 *and* 16 *of the triple-valve case in the brake-cylinder, forcing out the piston, and, through an appropriate system of levers and connections, applies the brake.*" This certainly is one function of the triple valve, and is such as I described as function "2nd" in answer 6.

As to "3rd" function set forth in my answer 6, the specification of patent 360,070, lines 43 to 49, states as follows:

"When the piston 12 arrives at the extremity of its stroke, as above specified, the supplemental port 35 of the slide-valve 14 is brought into communication with the port 33 and passages 22 and 16, *which serves to discharge the reservoir pressure to the brake-cylinder.*"

910 From this description of the specification of patent 360,070, there can be no doubt that there are two valves of the triple valve proper which admit air from the auxiliary reservoir to the brake-cylinder in the complainants' quick-action triple-valve device, which valves are, first, the graduating valve 29 that admits the auxiliary reservoir air to the brake-cylinder by the preliminary stroke of the piston, and second, the valve formed by the port 35, which admits auxiliary reservoir air to the brake-cylinder by the final movement of the piston.

In my answer 6, as before stated, I first described the function of those valves forming the triple valve, and after doing so I then immediately described the function of the auxiliary valve 41, the whole together being a description of the function of the five valves in the complainants' quick-action triple valve.

X 147 Q. Your answer is, of course, fully responsive to the question, inasmuch as you say you will *not* make the admission asked for, but, inasmuch as it seems to me that you have not fully and clearly apprehended the question, I think it is only fair to give you a final opportunity of correcting the error of fact which exists in your answer 6, by repeating X Q. 146, and calling your attention to the fact that the correction suggested to you is such a correction as would make your recital of functions specified, accord and agree with the *actual* and *practical* operation of the quick-action triple valve of patent 360,070, as well as with its *normal* and *intended* operation, as described in the portion of the patent recited in the question.

I therefore repeat X Q. 146.

A. After considering the matter, I think the functions of the five valves are as I have set forth in my 6th answer.

X 148 Q. Don't you know perfectly well that the alleged function of the valve mechanism of patent 360,070, which you have recited in answer 6 as "3rd, to admit auxiliary reservoir air to the brake-cylinder through the valve port 35 by the final movement of the piston 12" has nothing whatever to do with the quick-action
911 triple valve of patent 360,070, *when operating as what you call "a triple valve proper, and as used in the art prior to* 1887."

Don't you also know perfectly well that the admission of "auxiliary reservoir air to the brake-cylinder through the valve port 35 by the final movement of the piston 12," is effected, and is *only* effected, as *auxiliary* to and *subsequently* to the opening of the valve

41, to admit air directly from the main air pipe to the brake-cylinder, and *is not effected under any other circumstances or conditions?* I call your attention to the closing clause of the description of the operation of opening the port 35, which you carefully avoided to quote when specifying a part of the patent which you claimed recited your alleged function 3rd, and which reads: "Thereby augmenting the pressure already exerted in the brake-cylinder by the air admitted from the main air pipe." Please avoid needless delay by giving a categorical answer to each branch of the question.

A. No, I do not know perfectly well that the third function as described in my 6th answer is not a function of the triple valve; because when the device is operating as a quick-action-valve device, the port 35 is admitting the auxiliary reservoir air to the brake-cylinder; and therefore it is performing one of the triple-valve functions.

As to the second part of your question, my understanding is that the port 35 will perform a triple-valve function without the auxiliary valve 41 admitting main air-pipe air to the brake-cylinder, and I have stated such an operation in my answer to X Q. 48, pertaining to section (*b*) of said cross-question, and possibly elsewhere.

Answer objected to by counsel for complainants as not being in anywise responsive to either branch of the question, the witness having utterly ignored the italicised portion of the first branch of the question, and also ignored the essential condition of the
912 second branch of the question, which specifies "the opening of the valve 41."

X 149 Q. X Q. 148 repeated, the witness' attention being called to the essential portions of the question ignored by him in his answer thereto as specified in the objection just made by counsel.

A. My understanding is that when the piston has made its final movement the valve formed by the port 35 will be opened and thereby admit the auxiliary reservoir air to the brake-cylinder, performing one of the functions of the triple valve; at the same time, the valve 41 will also be opened, and it will admit air from the main air pipe to the brake-cylinder simultaneously with the admission of the auxiliary reservoir air to the brake-cylinder through the valve formed by the port 35, provided there is sufficient pressure in the main air pipe to pass to the brake cylinder; but if there was not sufficient pressure in the main air pipe, there would be no air pass from the main air pipe to the brake-cylinder. Such a condition as last mentioned could exist as stated by me in answer to X Q. 48, section (*b*) of said answer.

Same objection.

X 150 Q. X 148 Q. again repeated, and a categorical answer requested to each branch of the question.

A. The answers I have made to the question are the best that I

can make, as that is my understanding of how the device could operate.

Same objection.

X 151 Q. Do you refuse to give a categorical answer to X Q. 148?

Objected to as an improper cross-examination, the witness having fully explained his meaning in a responsive answer to the question, and having stated reasons which show that, according to his understanding of the subject-matter, it would not be proper for him to give a categorical answer, as such an answer would not state the *whole* truth according to the witness' understanding of the matter.

913 Counsel for complainants request the witness to answer the question and not the objection of defendants' counsel.

A. I decline to give a categorical answer for the reasons before stated by me.

X 152 Q. Referring you to the description of the operation of the Westinghouse quick-action triple valve of patent 360,070, contained between line 80, page 3, and line 51, page 4, of said patent, it is the fact, is it not, that the functions, and the *only* functions, of the valve mechanism, as recited in such description of operation are:

1st. To admit air from the main air pipe to the auxiliary reservoir (see line 80 to the numeral "15" line 93, both inclusive, page 3, and observe that the passage is characterized by the presence of the words "air passes into the auxiliary reservoir 6.")

2nd. To admit air from the auxiliary reservoir to the brake-cylinder through the port controlled by the graduating valve 29 (see from "to," line 93, to "pipe," line 129, both inclusive, page 3, and observe that the passage is characterized by the presence of the words "to apply the brakes in making ordinary stops.")

3rd. To exhaust air from the brake-cylinder to the atmosphere (see from "to," line 129, page 3, to "service," line 13, page 4, both inclusive, and observe that the passage is characterized by the presence of the words "to release the brakes.")

4th. To effect the admission of air directly from the main air pipe to the brake-cylinder, accompanied by a subsequent admission of auxiliary reservoir air through the port 35 (see from "in," line 13, to "pipe," line 51, both inclusive, page 4, and observe that the passage is characterized by the presence of the words "to apply the brakes with great rapidity and with their greatest available force.")

A. Yes, those are the functions set forth in the patent specification referred to.

X 153 Q. It is also the fact, is it not, that the only descrip-
914 tion of the operation of the quick-action triple valve of patent 360,070, as relates to its action "to admit auxiliary reservoir air to the brake-cylinder through the valve port 35 by the final movement of the piston 12," which is recited in said patent, is that which is given in the following language (at the close of the description of the operation of the valve mechanism in effecting the

admission of air directly from the main air pipe to the brake cylinder) to wit:

"When the piston 12 arrives at the extremity of its stroke, as above specified, the supplemental port 35 of slide-valve 14 is brought into communication with the port 33, and passages 22 and 16, which serves to discharge the reservoir pressure into the brake-cylinder, thereby augmenting the pressure already exerted in the brake-cylinder by the air admitted from the main air pipe."

A. That is my understanding of specification of patent 360,070; but the specification also refers to the action of the triple valve patented October 14th, 1879, No. 220,556, in that it states "the triple valve 10 accords substantially with that set forth in letters patent of the United States No. 220,556, granted and issued to me October 14, 1879." (See page 3, lines 37 and 40.)

All of the last preceding answer subsequent to the first clause thereof objected to by counsel for complainants as not being in the slightest degree responsive to the question, and as being an irrelevant volunteered statement.

X 154 Q. Do you desire the court to understand that you actually believe and assert that, in practice, the quick-action triple valve of patent 360,070 is normally operated, or is *ever* operated so as to admit auxiliary reservoir air to the brake-cylinder through the valve port 35, except as *auxiliary* to and *subsequently* to the opening of the valve 41 to effect the admission of air directly from the main air pipe to the brake-cylinder?

A. My understanding of the valve device is that auxiliary reservoir air can be admitted to the brake-cylinder through the port 35 without necessarily admitting main air-pipe air to the brake-
915 cylinder, and would operate so under conditions mentioned by me in answer to X Q. 48 in section (*b*) thereof.

Answer objected to by counsel for complainants as wholly irresponsive and as being merely an idle and tedious repetition of irrelevant matter which has been again and again stated by the witness.

X 155 Q. X Q. 154 repeated.

A. My understanding is that in practice the quick-action triple-valve device can operate to admit auxiliary reservoir air to the brake-cylinder through the port 35, without admitting air from the main air pipe to the brake-cylinder through the valve 41, and that such admission would be a normal operation of the valve——

Same objection.

Witness (continuing):—under certain conditions.

X 156 Q. X Q. 154 again repeated, witness being instructed that no hypothetical considerations as to what might, or could, or ought to be done with the valve enter into the question, and that he is asked only as to the manner in which he supposes or knows (if he does know) in which the triple valve of patent 360,070 *is normally operated*, or is *ever* operated in practice.

A. In case the hose should burst, or become disconnected, the pressure in the main air pipe would be instantly reduced under the cars where the rupture took place; this would cause the piston of the triple valve to move its full stroke, and admit the auxiliary reservoir air to the brake-cylinder through the port 35; but as the pressure in the main air pipe had been exhausted by the rupture, it could not pass to the brake-cylinder; therefore, under this condition, which is a normal action, and an intended action, air from the auxiliary reservoir would be admitted to the brake-cylinder through the port 35, but no air from the main air pipe would be admitted.

Same objection.

X 157 Q. X Q. 154 again repeated.

A. That is the best answer I can make to the question.

916 X 158 Q. If it is your belief, and if you assert, that in practice the quick-action triple valve of patent 360,070 is *normally* operated, or is *ever* operated, so as to admit auxiliary reservoir air to the brake-cylinder through the valve port 35, except as *auxiliary* to and *subsequently* to, the opening of the valve 41 to effect the admission of air directly from the main air pipe to the brake-cylinder, please state whether you have any actual and personal knowledge of such operation ever having been effected in practice, and, if so, when, where and by whom such a remarkable performance was made?

A. I have no personal knowledge of such operation in actual practice, as I never made actual tests in practice with the device shown in complainants' patent 360,070; but I believe it would operate as I have stated under the conditions named.

X 159 Q. Are you in anywise laboring under the delusion that instructions to operate the triple valve of patent 360,070 in the manner in which you think it can be made to operate are issued by the corporation complainant in its catalogues or instruction books or in any other matter published by it for the guidance and information of users of the device?

A. I am not; but the operation I described in my near preceding answers is an automatic operation which the device itself would perform without any action of the persons having charge of the train.

X 160 Q. Inasmuch as you have never made any actual tests with the triple valve in patent 360,070, your statement in the last preceding answer as to the alleged "automatic operation" which you think the device would perform, is merely a statement of your own opinion, and is not based upon any actual and personal knowledge whatever of the operation of said device. Am I not correct?

A. It is not based on any practical operations I have made with the device.

X 161 Q. As a mechanical engineer, and air-brake expert, will you now admit that it is simply a *physical impossibility* for
917 the quick-action triple valve of patent 360,070 to perform what you have called function "3rd" in your answer 6,

until the piston 12 has been moved into such position as effects the opening of the valve 41 and the uncovering of a port for the passage of air directly from the main air pipe to the brake-cylinder?

A. I will admit that I consider it a physical impossibility to open the port 35 without opening the valve 41.

Recess.

X 162 Q. In view of your preceding answers in cross-examination, I *now* understand that your only warrant or basis for specifying in answer 6 the alleged function "third" as one of the functions performed by the quick-action triple valve of patent 360,070, when operating "as a triple valve proper and as used in the art prior to 1887," is your belief that that device *could* perform the alleged "automatic operation" referred to in your answer 159. Am I correct?

A. You are, as I have made no practical test with the device shown in complainants' patent 360,070. I understand they have not been put on the market, and I have had no opportunity of making any tests with them in practice.

X 163 Q. Is it not the fact that your object in, and reason for, reciting, in answer 6, the alleged function "third" as one of the functions performed by the quick-action triple valve of patent 360,070, when operating "as a triple valve proper and as used in the art prior to 1887," was to endeavor to make such recital serve as a basis for the following assertion made by you in answer 9, to wit:

"The four valves above described (being, as termed by you: 1st, feeding-in valve 51; 2d, exhaust valve formed by the port 33; 3d, graduating valve 29; 4th, main valve formed by the port 35) form a 'triple valve' proper in both the complainants' and defendants' devices, and, disregarding mere matters of form, are the same
918 as are described as a triple valve in complainants' patent 360,070 and the Westinghouse patent 220,556, dated October 14, 1879."

A. No; it was not; as, when I was asked to explain complainants' quick-action triple valve, I found therein four valves that operated to perform triple-valve functions, viz: 1st, the feeding-in valve; 2d, the exhaust valve; 3d, the graduating valve, opened by the preliminary movement of the piston, and 4th, the valve formed by the port 35, opened by the final movement of the piston. These four valves, in addition to the auxiliary valve 41 existing in the device, I could not consistently give a description of the same, and omit mentioning the valve opened by the port 35 as performing one of the triple-valve functions.

X 164 Q. If your object in reciting, in answer 6, the alleged function "third" as one of the functions performed by the quick-action triple valve of patent 360,070, when operating "as a triple valve proper, and as used in the art prior to 1887," was *not* the object which I have suggested in X Q. 163, I wish you would state, for the information of the court, just what your object *was* in interjecting the alleged function "third," particularly in view of your admission

that your only warrant or basis for specifying said "function" was your belief that the device in patent 360,070 *could* perform some supposed automatic operation, of which you had no actual or personal knowledge?

A. The object I had in view was to point out to the court the four valves that formed the triple valve proper, as forming that part of the complainants' quick-action triple-valve device which constituted the "triple valve," and which was old prior to 1887. I then pointed out the auxiliary valve 41, which admits the main air pipe to the brake-cylinder, as that part which was added as the *new element* to the old triple-valve structure.

X 165 Q. Don't you think now that you incurred great risk of misleading the court when you undertook to allege as a normal and intended function of the device in patent 360,070 a function,
919 for the allegation of which your only basis is a supposition as to some automatic operation which the device *could* perform, without any knowledge whatever as to whether you were right, and without a word of suggestion in the patent as to such automatic operation?

A. No; I don't think so. As I understand the matter I think the device would operate as I have stated, and I am satisfied that the functions of each valve I have pointed out are the correct ones.

X 166 Q. And you feel that you have done your duty to the court, do you, when you offer to it, as expert testimony, an unqualified statement that the device of patent 360,070 performs a certain "function" upon an unproved theory of your own, that said device *could* be made to perform some supposed "automatic operation" which is not mentioned, nor even hinted at, in the patent?

Objected to as improper cross-examination, the witness having described over and over again not only the particular automatic operation referred to in the question, but all the other operations of the device and its different parts.

A. I feel that I have, as I have had several years' experience with valves, that is, with quick-action valves, and I believe my statement of the device to be a truthful one as to the operation of the complainants' quick-action triple valve.

X 167 Q. Please quote the passage of the specification of patent 360,070, if any such passage there is, which you think, in the slightest particular, warrants or justifies the following statement made by you in answer 6, to wit:

"To apply the brakes fully with the auxiliary reservoir pressure by the final movement of the piston 12 *a sufficient amount of air is gradually exhausted from the main air pipe to move the piston its full stroke.* This will bring the valve port 35 coincident with the passage 22, and thereby establish communication from the auxiliary reservoir to the brake-cylinder, and fully apply the brakes with the reservoir pressure."

920 I call your attention specially to the portion of your allegation which I have italicised.

A. My understanding is there is no such paragraph or passage the specification.

X 168 Q. Now, as a matter of fact, there is neither a stateme nor even the remotest suggestion, in patent 360,070 that in orde effect *any operation whatever* of the valve mechanism of said pat "a sufficient amount of air is gradually exhausted from the m air pipe to move the piston its full stroke." Am I or am I not c rect?

A. My understanding is you are correct.

X 169 Q. It is in evidence in this cause, and, so far as I know, have reason to believe, is not disputed by the defendant, that betw 1,500 and 1,800 triple valves like that of patent 360,070 are in regu use in railroad service. Have you any knowledge that in operation of these triple valves, to effect *any operation whatever*, sufficient amount of air is gradually exhausted from the main pipe to move the piston the full stroke"?

A. I have no knowledge whatever of the 1,500 valves you m tion.

X 170 Q. You will now, I presume, admit upon the record t your statement made in answer 6, and quoted by me in X Q. 1 to wit: "To apply the brakes fully with the auxiliary reserv pressure by the final movement of the piston 12 a sufficient amou of air is gradually exhausted from the main air pipe to move t piston its full stroke. This will bring the valve port 35 coincide with the passage 22, and thereby establish communication from t auxiliary reservoir to the brake-cylinder, and fully apply the bra with the reservoir pressure," was and is incorrect in failing to speci *primarily and essentially*, the application of the brakes by the a mission of air directly from the main air pipe to the brake-cylind as being the application which is made when the parts of t

921 valve mechanism are brought, by the actuation of the en neers' valve, in such position as "will bring the valve p 35 coincident with the passage 22."

Will you make this admission?

A. My understanding of the valve device is that under certa conditions such an operation as I have described could be pe formed; but I am perfectly willing to admit that such an operati would not be a usual one, or one that might be necessarily used practice.

In describing the operation of the valve formed by the port 35 desire to state, that there may be no misunderstanding about t matter, the following:

In my testimony-in-chief I first pointed out those four valv which form the triple valve proper in order to make perfectly cle to the court what constituted the triple valve as it is understo prior to 1887. I then immediately followed with a description the auxiliary valve, which was an addition to the triple valve, perform the additional function of admitting main air-pipe pressu to the brake-cylinder.

In my explanation of how the valves, formed by the port 3 operated, I stated as follows:

"To apply the brakes fully with the auxiliary reservoir pressure by the final movement of the piston 12, a sufficient amount of air is gradually exhausted from the main air pipe to move the piston its full stroke. This will bring the valve port 35 coincident with the passage 22, and thereby establish communication from the auxiliary reservoir to the brake-cylinder, and fully apply the brakes with reservoir pressure."

My object in stating the third operation as I did was to show the means employed in the triple valve to admit the auxiliary reservoir air to the brake-cylinder when the piston had made its final movement or full stroke.

I did not wish to imply that the exact operation I described was material to or essential to the device shown in complainants' patent 360,070, but only used it to show how or by what valve the auxiliary reservoir air was admitted to the brake-cylinder when
922 the piston would have made its final movement or full stroke.

Therefore, if the description I gave in my answer 6 is likely to be misleading in any particular, I would restate it as follows:

To apply the brakes fully by the final movement of the piston 12, a sufficient amount of air is exhausted from the main air pipe to move the piston its full stroke. This will bring the valve 35 coincident with the passage 22, and thereby establish communication from the auxiliary reservoir to the brake-cylinder through the valve formed by the port 35.

Therefore, to the extent of the correction I have just made, I misstated the matter.

Answer objected to by counsel for complainant, as not in anywise responsive to the question.

Adjourned to Tuesday, May 9th, 1893, at 9.30 o'clock a. m.

MAY 9TH, 1893—9.30 o'clock a. m.

Met pursuant to adjournment.
Parties present as before.

X 171 Q. X Q. 170 repeated, and the witness is advised that he may, if he pleases, consider it as bearing just as fully on the restatement made by him in his last preceding answer as on his original statement in answer 6.

A. My understanding of the valve device is that under certain conditions the valve could be operated to admit air from the auxiliary reservoir to the brake-cylinder through the port 35, as stated in my 6th answer. At the same time I admit that such an operation would not be a usual one or one that might be necessarily used in practice. In my answer 6 I used that mode of explanation in order to show distinctly those valves that formed the triple valve. However, it is immaterial what the operation of the valve may be, that is to say, whether the main air-pipe air is admitted through the auxiliary valve 41 to the brake-cylinder simul-
923 taneously with the admission of the auxiliary reservoir air to the brake-cylinder through the port 35, or not, as under

this condition the valve formed by the port 35 is one of the triple valves, because in admitting the auxiliary reservoir air to the brake-cylinder it performs a triple-valve function.

Same objection.

X 172 Q. You refuse, then, to make the admission asked for in X Q. 170, do you?

A. As a whole, I do; because in several of my preceding answers I have stated how the air from the auxiliary reservoir could pass to the brake-cylinder through the port 35 without the air being admitted from the main air pipe through the auxiliary valve 41 to the brake cylinder.

X 173 Q. In the hope of bringing you to the knowledge that you are simply piling one error upon another, in declining to avail yourself of the opportunity offered you to correct your previous testimony, I now ask you to point out *any one* of your preceding answers in which you have stated how the air from the auxiliary reservoir could pass to the brake-cylinder through the port 35 without air being admitted from the main air pipe to the brake-cylinder, when "a sufficient amount of air is gradually exhausted from the main air pipe to move the piston its full stroke," as in your allegation quoted in X Q. 170?

A. Not understanding your X Q. 170 at first as fully as I do now, I admit that that part of my statement about the *gradual* discharge of air from the main air pipe by the engineer's valve, to fully apply the brakes with auxiliary reservoir pressure, was incorrect, and in making that statement it was with the intention to show the function of the valves formed by the port 35 when the piston had made its final or full stroke.

Recess.

X 174 Q. In view of what I presume you will not hesitate
924 to admit to be the impossibility of getting main air-pipe air into the brake-cylinder *after* the brake-cylinder has been charged with reservoir air, you are also incorrect, are you not, in stating, in answer 171, that it is immaterial whether the main air-pipe air is admitted through the auxiliary valve 41 to the brake-cylinder simultaneously with the admission of the auxiliary reservoir air to the brake-cylinder through the port 35, or not?

A. As to the first part of your question, I should say that it was an impossibility to get the main air-pipe air into the brake-cylinder, after the brake-cylinder had been charged with sufficient pressure from the auxiliary reservoir to prevent the admission of the main air-pipe air.

As to the second part of your question, I consider it immaterial whether the main air-pipe air is admitted to the brake-cylinder simultaneously with the admission of auxiliary reservoir air or not, so long as the amount of air from the auxiliary reservoir admitted to the brake-cylinder is sufficiently restricted not to interfere with the admission of main air-pipe air to the brake-cylinder.

X 175 Q. Still referring to the *kind* of application of the brakes

BLEED THROUGH POOR COPY

which would be effected when auxiliary reservoir pressure is admitted to the brake-cylinder through the valve port 35, you are also incorrect, are you not, in illustrating said port 35 in drawings Nos. 1, 3, 5 and 7 of Defendants' Exhibit Illustrative Cuts Nos. 1 to 10, inclusive, as *larger* than the port controlled by the graduating valve 29 when patent 360,070 distinctly shows the port 35 to be materially *smaller* than the port controlled by the graduating valve 29?

A. As compared with the patent, the size of the port 35 is larger in the cuts than in the drawing of the patent; however, my object in using the cuts was to show the *functions* of the different valves, and not the capacity of them. Had I noticed that the port 35 in the cuts was larger in comparison than the graduating port, I would have had it made to correspond with the proportions
925 shown in the patent, as I have no object in showing it otherwise.

X 176 Q. I do not desire to intimate that you had any improper object in doing what you did, and am only inquiring as to the correctness of your statements and illustrations. I understand from your answer to X Q. 175 that you mean to answer that question in the affirmative and without qualification. Is this the fact?

A. It is.

X 177 Q. You are also incorrect, are you not, in omitting to illustrate by a blue line, in drawing No. 5 of Defendants' Exhibit Illustrative Cuts, the course of the air from the main air pipe to the brake-cylinder through the port uncovered by the valve 41, in the same manner as such traverse of main air-pipe air is illustrated in drawing No. 7?

A. No, I am not, as I used cut No. 5 *only* to show the course of the auxiliary reservoir air to the brake-cylinder when passing through the port 35, in my answer to question 9.

X 178 Q. Do you pretend to say that with the parts in the position shown in drawing No. 5, main air-pipe air would *not* pass to the brake-cylinder in the course substantially as indicated by the blue line in drawing No. 7?

A. No, I do not, provided the air was in the main air pipe with sufficient pressure to pass to the brake-cylinder. I did not use cut 5, or testify to it, other than to show the course of the air from the auxiliary reservoir to the brake-cylinder; nor did I intend to represent the complete operation of the valve, such as when producing a quick action, or otherwise.

X 179 Q. What you *did* use drawing No. 5 for was to attempt to illustrate the performance of an alleged function of patent No. 360,070, recited in your answer 9, under the head of "fourth valve," being the alleged function "3rd" of your answer 6.

Now, in view of your admission that your only warrant for the allegation of said function, is your belief that the device of
926 patent 360,070 *could* perform an alleged "automatic operation," referred to in your answer 159, I ask you whether drawing No. 5 is not misleading and deceptive, in failing to indicate the course of the main air-pipe air, when it pretends to represent the performance of a function as to which in and up to answer

9, and, in fact, up to a comparatively late period in your cross-examination, you did not give the least intimation, was an "automatic operation"?

A. Drawing No. 5 is not misleading or deceptive, as, in using that drawing, I was merely pointing out the functions performed by the valve port 35, and in my answer 9, pertaining to cut 5, I only discussed the function of the valve port 35, irrespective of how it would operate under any condition; and my opinion is that the function of the port is properly stated in said answer 9. It is true that if the cut had been intended to represent the "quick action" of the brake, *then* it should have been provided with a blue line; but it was only used for the *one* purpose of showing the course of the auxiliary reservoir air to the brake-cylinder, and to point out the function of the valve port 35 when the piston had made its final stroke.

X 180 Q. Was or was not drawing No. 5 intended to truthfully and correctly represent the performance of the function which would actually be performed by the device of patent 360,070, when the parts thereof were brought into the position shown in said drawing?

A. Drawing No. 5 was truthfully intended to represent the course of the air from the auxiliary reservoir to the brake-cylinder, and the function of the port 35, when the piston has made its full and final stroke.

Answer objected to by counsel for complainants as not responsive.

X 181 Q. X Q. 180 repeated and a categorical answer requested.

A. Drawing No. 5 was intended to truthfully and correctly represent the performance of the function of the port 35, and the port 35 would perform this function whenever the piston had made its
927 final stroke, provided the pressure in the auxiliary reservoir was greater than in the brake-cylinder.

Same objection.

X 182 Q. X Q. 180 repeated; and, in order to save further needless delay, the witness is requested either to give a categorical answer as asked for, or to say that he refuses to do so.

A. I have stated what I used the cut No. 5 for, and what it is to represent; and having made the best answer I can to the question, I decline to give a categorical answer.

Same objection.

X 183 Q. Does, or does not, drawing No. 5 truthfully and correctly represent the performance of the function which would actually be performed by the device of patent 360,070, when the parts thereof are brought into the position shown in said drawing?

Objected to as improper cross-examination, simply badgering the witness and wasting time. The witness has testified that cut No. 5 was intended to represent *one* of the several functions of the mechanism; that it *does* represent that one and represents it correctly. Having *intended* to illustrate one function, there was no reason why

BLEED THROUGH POOR COPY

he should illustrate another and different one; and, moreover, in connection with cut No. 5, the witness submitted cut No. 7 to illustrate *both* functions.

Counsel for complainants again protests against the interpretations of the witness' testimony, and the plain instructions as to what his further testimony shall be, made in the guise of objections by defendants' counsel.

Defendants' counsel says that he intends, by his objection, to call the attention of the court to the badgering character of the cross-examination.

Counsel for complainants submits that if the cross-examination be of such character the intelligence of the court will readily
928 discern it on an inspection of the record, and further that argument as to the character of the cross-examination can be more properly made, and be made with less loss of time, at the hearing than during the taking of depositions.

A. Drawing No. 5 *does* truthfully represent the function of the port 35, but is *not* intended to represent the functions of the other parts, and I desire it to be understood as only representing the function of port 35 when the piston has made its final or full stroke, irrespective of what functions the other parts would or could perform when the parts are in the position as shown on drawing 5.

Same objection.

X 184 Q. X Q. 183 repeated, the witness being requested either to give a categorical answer or to say that he refuses to do so.

Same objection.

A. I have answered the question to the best of my ability and have stated fully what cut 5 was intended to illustrate or demonstrate; therefore I decline to give a categorical answer.

Same objection, and counsel for complainants asks the attention of the court to the witness' persistent refusal to answer the *whole* truth as to the illustration or drawing prepared and submitted by him to the court.

Defendants' counsel submits that the above remarks are grossly improper.

X 185 Q. Referring again to your statement in answer 6, quoted by me in X Q. 167, please explain fully to the court how, if at all, (in view of your answers 142 and 144) it is possible to apply the brakes any more "*fully*," with *auxiliary reservoir* pressure, by the valve mechanism of patent 360,070, when auxiliary reservoir air is caused to pass through the valve port 35 and passage 22 (as in your statement quoted) than they would be applied, with auxiliary reservoir pressure, when auxiliary reservoir air is caused to pass
929 through the port 31, controlled by the graduating valve 29, and the passage 22 (as in your function "2nd" of answer 6)?

A. My understanding of the matter is that the auxiliary reservoir

pressure would not be *more* fully applied to the brake-cylinder through the port 35 than it would be through the port controlled by the graduating valve 29. I have looked over my answers you referred to and I *do not find therein* a statement that the air would be *more* fully applied through the port 35 than through the port controlled by the graduating valve 29.

X 186 Q. Inasmuch as the port 35 is materially smaller in patent 360,070 than the port 31, controlled by the graduating valve 29, if there be any difference in the *fullness* of the application of the brakes by the admission of reservoir air through the port 35, or through the port 31, the brakes would be applied *more* fully by the admission of reservoir air through the larger port 31 than they would be by its admission through the smaller port 35. Is not this correct?

A. My understanding of the device shown in patent 360,070 is that the brakes could not be more fully applied by either of the ports 35 or 31; but my opinion is that the auxiliary reservoir pressure would be applied to the brake-cylinder *more quickly* through the port 31, provided the graduating valve 29 was continuously held open, than it could be through the port 35, because the port 31 is larger than port 35 in the patent.

Adjourned to meet at same place at 9.30 o'clock a. m., May 10th, 1893.

WEDNESDAY, *May 10th*, 1893—9.30 a. m.

Met pursuant to adjournment.

Parties present as before.

X 187 Q. I understand from your answer 24 that there is no difference in mode of operation, in the performance of the four functions recited in the first paragraph of your answer 9, between
930 defendants' quick-action triple valve, plate IX, defendants' 1889 catalogue, and defendants' quick-action triple valve, plate XI, defendants' 1891 catalogue. Am I correct?

A. There is no difference in the mode of operation between the defendants' two valves shown in the catalogues of 1889 and 1891.

X 188 Q. Could not X Q. 187 have been properly and truthfully answered categorically in the affirmative?

A. I think not; and my reason for stating it the way I did was that in my answer 9 I was comparing the functions of the defendants' quick-action triple valve with complainants' patent 360,070. If your question merely pertains to the functions of the defendants' two valves, 1889 and 1891 catalogues, my answer is yes.

X 189 Q. If you have in anywise misunderstood X Q. 187 I will repeat it, and do repeat it, stating that there is nothing whatever meant or implied in the question, except as to the identity of mode of operation of defendants' 1889 and 1891 valves, in the performance of the four functions which you recite in the first paragraph of answer 9.

Please answer categorically.

A. You are.

X 190 Q. You say in answer 7, referring to defendants' quick-

action triple valve, plate XI, defendants' 1891 catalogue, "I invented this valve device, and it is the outcome of a prior invention of mine which was patented June 26, 1883, No. 280,285."

The "valve device" to which you refer, to wit: defendants' quick-action triple valve, plate XI, defendants' 1891 catalogue, is itself patented in and by your letters patent No. 481,135, August 16th, 1892, a copy of which is in evidence. Is not this the fact?

A. It is.

X 191 Q. And it is also the fact, is it not, that defendants' quick-action triple valve, plate IX, defendants' 1889 catalogue, is patented in and by your letters patent No. 481,134, August 16th, 1892, a copy of which is in evidence.

931 A. It is; and this patent (481,134) contains the broad claims of the invention—patent 481,135 being for the special construction shown in plate XI of defendants' 1891 catalogue.

X 192 Q. It has been admitted by counsel for defendants for the purpose of this suit (see Complainants' Record, page 61) that quick-action triple valves, such as are shown in plate IX, defendants' 1889 catalogue, and described on pages 23 and 24 thereof, were made, sold and used by the corporation defendant prior to the filing of the bill in this cause, said triple valves being used in connection with other members, substantially as indicated in Complainants' Exhibit Drawing Defendants' Quick-action Brake-valve and Connections.

As president of the corporation defendant you will, I presume, admit the substantial correctness of the facts as above stated, and will also admit that such manufacture, sale and use was subsequent to March 29th, 1887, the date of the complainants' patent in suit?

A. I will.

X 193 Q. I understand your statement in answer 8, to wit: "I wish to state here that my 1883 patent was not for a 'quick-action' valve (as that term is now understood)," to refer to your patent No. 280,285 in evidence.

I also understand from your above-quoted statement in answer 8, that your statement in answer 7 that the valve device (plate XI defendants' 1891 catalogue) is the "outcome" of a prior invention of yours, is *not* intended to mean that said valve device (plate XI, defendants' 1891 catalogue) was the "outcome" of, or was the successor to, or was an improvement upon, any prior invention of yours which embodied a valve mechanism designed for, or capable of, use in effecting the application of the brakes with maximum rapidity and force, by the admission of air directly from the main air, or train, pipe to the brake-cylinder, resultant upon reduction of main air, or train, pipe pressure.

Am I correct as to either or both branches of the question?

932 A. As to the first part of your question, you are correct.

You are correct as to the second branch of the question. In my 1883 patent, I had arranged therein one valve through which air from *both* the main air pipe and auxiliary reservoir would pass to the brake-cylinder, and I embodied this feature in defendants' quick-action triple valve (plate XI, defendants' 1891 catalogue.)

All of the last preceding answer, subsequent to the first sentence thereof objected to by counsel for complainants as not in the slightest degree responsive to the question and as an irrelevant volunteered statement.

X 194 Q. As a matter of fact, said valve device (plate XI, defendants' 1892 catalogue), so far as relates to its design for, or capability of, use in effecting the application of brakes with maximum rapidity and force, by the admission of air directly from the main air, or train pipe, to the brake-cylinder, resultant upon reduction of main air, or train pipe pressure, was the *outcome*, and *directly* the outcome of the prior invention of George Westinghouse, Jr., set forth in patent 360,070 in suit. Is not this the fact?

A. No; it is not the outcome of that patent. It is true I was familiar with the Westinghouse patent 360,070 at the time I designed the defendants' quick-action triple valve; but previous to being familiar with complainants' patent I had made experiments in depleting the train-pipe pressure to quicken the serial application of the brakes.

X 195 Q. You say in answer 8 (referring to defendants' quick-action triple valve and to the triple valve of your patent No. 280,285):

"In both devices train-pipe air (shown by the blue lines) and auxiliary reservoir air (shown by the red lines) enter the triple-valve chamber, and both pass to the brake-cylinder through the same port uncovered by the one valve."

You, however, inadvertently omitted to also state that the *intended* (as well as the *actual*) result is *not* the same in both
933 devices, and that, in defendants' quick-action triple valve, such passage of main air-pipe air and auxiliary reservoir air to the brake-cylinder, effects a "quick-action" or "emergency" application of the brakes, while in the triple valve of patent 280,285, *no application whatever* of the brakes is effected by the passage of main air-pipe air to the brake-cylinder, and no main air-pipe air is admitted to the brake-cylinder until *after* the brakes have been applied, with the maximum rapidity and force within the capacity of the device, *by auxiliary reservoir air alone.*

The statement which I have above recited as having been omitted by you, is absolutely and *unqualifiedly* true, is it not?

A. When I compared the defendants' quick-action triple valve with the device shown in my 1883 patent, my only object was to show that it was common in both devices to admit air from both the train-pipe and auxiliary reservoir to the brake-cylinder *by one valve.* I did not wish to imply, nor do I now, that my 1883 patent was for a quick-action valve such as you have stated. I did not "inadvertently" omit the matter you have suggested, as I considered the same as irrelevant in my answer 8. However, what you say about the 1883 patent is correct.

X 196 Q. Was a triple valve similar to that of your patent No. 280,285, ever put into practice in railroad service, and if so, when, where, for how long and with what results in operation?

A. It was never put in actual railroad service.

X 197 Q. The functions assigned by you in the first paragraph of answer 7 to defendants' quick-action triple valve (plate XI, defendants' 1891 catalogue), designated as 1st. 2nd, 3rd and 4th, and succeeded by the statement, "These four valves form what is commonly known as a 'triple valve' used in the art prior to 1887," correspond, respectively, do they not, with the similarly designated alleged functions, which, in answer 6, you assigned to the valve mechanism of patent 360,070?

934 A. They do.

X 198 Q. Does function "3rd" of the first paragraph of your answer 7, constitute a feature, or an *essential* feature, of operation, of defendants' quick-action triple valve, (plate IX, defendants' 1889 catalogue)?

A. It does.

X 199 Q. Referring you to the description of defendants' quick-action triple valve (plate IX, defendants' 1889 catalogue) found on pages 23 and 24 of said catalogue, it is the fact, is it not, that the *only* "function," or mode of operation, recited in said description of the device, when operating "as a triple valve used in the art prior to 1887," in effecting the supply of auxiliary reservoir air to the brake-cylinder, is the function of admitting said air through the port controlled by the graduating valve (as in function "2nd" of your answers 6 and 7)?

A. It is; but, by inadvertence, a description was omitted in the catalogue as to how, or through what valve, the auxiliary reservoir air was admitted to the brake-cylinder when the piston had made its full stroke.

X 200 Q. It is also the fact, is it not, that the member in plate IX, defendants' 1889 catalogue, which corresponds with what you call the "main valve" 22 of plate XI, defendants' 1891 catalogue, is not even dignified with a symbol of reference in the 1889 catalogue, and is merely termed, in the descriptive matter thereof, "the plug that is integral with the piston 5?"

A. It is the fact.

X 201 Q. Defendants' quick-action triple valve (plate IX, defendants' 1889 catalogue) corresponds, does it not, in all substantial particulars of construction and operation, with the quick-action triple valve described and shown in your patent 481,134, in evidence?

A. It does.

X 202 Q. Referring you to said patent 481,134, it is the fact, is it not, that the *only* "function" or mode of operation recited therein, of the quick-action triple valve described and shown, when operating "as a triple valve used in the art prior to 1887," in effecting

935 the supply of auxiliary reservoir air to the brake-cylinder,

is the function of admitting said air through the port controlled by the graduating valve, (as in function "2nd" of your answers 6 and 7)?

A. It is; but on page 2, lines 25 to 28, the valve F is mentioned to open and close communication with the brake-cylinder C^1 from both *the auxiliary reservoir* R^1 and train-pipe P^1, thus plainly indi-

ing it there until the brakes are applied with the desired force," this passage indicating that in making a service stop the engineers' valve would be placed in said position and held there until the brakes were applied with the desired force, meaning, of course, to stop the train and thereby applying the brakes as set forth in paragraph "to apply the brakes fully (not a quick action)."

Recess.

X 210 Q. "Position 4," specified in the instructions as to manipulation of the engineers' brake-valve, quoted by me from page 37 of defendants' 1891 catalogue, is the position into which the handle of the engineers' brake-valve is moved to cause the quick-action triple valve (plate XI, 1891 catalogue) to perform function "2nd" of your answers 6 and 7, that is, "to apply the brakes by graduation," as specified in the paragraph beginning with those words on page 28 of the catalogue. Is not this the fact?

A. It is, as it is also the position to apply the brakes fully (not by a quick action,) the different actions of the triple valve being produced by intermittingly discharging the air from position 4 to graduate the brakes, and the continuous discharge from position 4 to fully apply the brakes (not a quick action.)

X 211 Q. And said "position 4" is indicated in plate V, defendants' 1891 catalogue (illustrating the engineers' brake-valve,) and is there marked "graduating position," is it not?

939 A. Yes.

X 212 Q. Is any position specified in the instructions as to the manipulation of the engineers' brake-valve in defendants' 1891 catalogue, or indicated on plate V thereof, for the performance of function "3rd" of your answers 6 and 7, that is, "to apply the brakes fully (not a quick action,") as specified in the paragraph beginning with those words on page 28, defendants' 1891 catalogue?

A. There is not.

X 213 Q. Would it be possible, in your opinion, to provide a definite "position" or "graduated stop," (as so termed in defendants' 1891 catalogue, page 15,) for the engineers' brake-valve, by a movement of the valve handle by which the engineer could, in practice, effect the opening of the valve 22 of defendants' quick-action triple valve (plate XI, defendants' 1891 catalogue) sufficiently to effect a greater or more rapid flow of air from the auxiliary reservoir to the brake-cylinder than is effected through the graduating valve port, *without* effecting a quick-action application of the brakes?

A. Yes; it could have been indicated by making "graduating positions" read "graduating position or full service stop."

X 214 Q. If you think, and I understand you do, that such definite positions, or graduated stop, could be provided, would it be correct for trains of different lengths; or, in other words, would not such reduction of main air-pipe pressure as would be made when the handle is placed in such position, which might effect the opening of the valve 22 *without* effecting a quick-action application on a train of a certain length, entirely fail to do so, on a *longer* train,

and undoubtedly effect a quick-action application on a *shorter* train?

A. The valve is so constructed that it will not effect a quick application on a train consisting of one car and a locomotive, so long as the handle remains in position 4. I should, say, however, that on a very long train, say fifty cars, there would not be suffi-
940 cient air discharged in a given time to unseat the valve 22, especially on the latter part of the train.

X 215 Q. I am satisfied that you have no intention of evading a full and fair answer to X Q. 214, but I do not think that you have fairly understood it. I, therefore, repeat it, and, in case you think you have understood it, ask you to give it a little more thought and see if you have not been far above the mark in specifying a train of fifty cars, and much below the mark in specifying a train of one car and a locomotive.

A. I think I fully understand the question; and as to the quick action on a train of one car and a locomotive, I am satisfied I am correct, because I have tried the same, and in fact every engineers' valve manufactured by our company is tested to see that it does *not* give a quick action to the brake on a train consisting of one car and a locomotive. As to the non-opening of the valve 22 on a long train, I have never made any tests to ascertain just on what car valve 22 would cease to be unseated. It may be ten, twenty or thirty, or more—I can't say.

X 216 Q. Is it your opinion that because, by the delicate, careful and comparatively deliberate manipulation which is practiced on a testing rack, you find that it is possible to get the valve 22 off its seat without effecting a quick-action application, it is a reasonable, safe or well-founded assumption that such a manipulation would be a practicable one, or could and would be regularly performed in actual practice in railroad service, with the result of effecting with certainty the alleged full application of the brakes (not a quick action) prescribed on page 28 of defendants' 1891 catalogue?

A. My opinion is that it could, with a careful engineer.

X 217 Q. As I understand defendants' quick-action triple valves of plate IX, defendants' 1889 catalogue, and plate XI, defendants' 1891 catalogue, the *initial* limit imposed upon the flow of air from the auxiliary reservoir to the brake-cylinder, through the
941 valve chamber C, is the area in transverse section of the port B, in the partition surrounding the hollow stem of the piston. Is such understanding correct?

A. It is.

X 218 Q. And it is also the fact, is it not, that so long as an equal area of transverse section is provided in any and every port between the port B and the brake-cylinder, the maximum quantity of auxiliary reservoir air capable of being delivered through said port B, in any given time, will pass from the chamber C to the brake-cylinder as fast as it is delivered to said chamber through the port B?

A. When the air is admitted to the brake-cylinder by the graduating valve, its flow therethrough, under any condition, is less than

that which passes from the auxiliary reservoir through the port B. When the air is reduced in the main air pipe sufficient to cause the valve 22 to slightly unseat, it will open the port formed thereby to a slightly greater extent than the capacity of the port B, thereby admitting auxiliary reservoir air to the brake-cylinder by the unseating of the valve 22.

Answer objected to as not in the slightest degree responsive to the question.

X 219 Q. X Q. 218 repeated, witness' attention being called to the fact that he is not asked anything about the graduating valve, or the valve 22, and *is* asked specifically as to the capabilities of port areas.

A. If the discharge port between the chamber C and brake-cylinder is of the same area as port B, then I should say you are correct.

X 220 Q. Could not X Q. 218 have been truthfully and correctly answered categorically in the affirmative?

A. It could; and I should have answered it that way if I had understood the question as I do now.

X 221 Q. As you now understand X Q. 218, I repeat it, requesting that you answer it categorically.

A. Yes.

X 222 Q. And it is also the fact, is it not, that in defendants' quick-action triple valve, plate IX, 1889 catalogue, the port
942 controlled by the graduating valve 13 is of *greater* transverse area than the port B (or as marked on said plate *e*)?

A. As shown on plate IX, it is; but, in practice, the port *e* is larger than the port opened by the graduating valve 13 on plate IX.

X 223 Q. So long as the port controlled by the graduating valve is equal to or greater in diameter than the port B (or *e*), *no more* air would pass from the auxiliary reservoir to the brake-cylinder in a given time, by opening *a still larger* port than the port controlled by the graduating valve (as, for instance, the port controlled by the valve 22) than would pass through the graduating valve port. Is not this the fact?

A. It is a fact; but, in practice, the port *e* in plate IX, or B in plate XI, is always larger than the port opened by the graduating valve.

X 224 Q. The relative diameter of the port *e* (or B) and of the graduating valve port is merely a matter of degree, is it not, and has no relation whatever to the operation of the quick-action triple valve (plate IX, defendants' 1889 catalogue,) as described in said catalogue and in your patent No. 481,134, with which, as you have admitted, said valve accords?

A. It is not a matter of degree, but it is essential in the operation of the valve devices that the port *e* (or B) should be larger than the graduating port, and my recollection of the device shown on plate IX, that there were three ports or passages made in the partition

dividing the valve chamber from the piston chamber each the size of the port *e*.

X 225 Q. Please quote fully upon the record any portion of the description of the construction and operation of defendants' quick-action triple valve (plate IX, defendants' 1889 catalogue) existing in said catalogue or in your patent No. 481,134, which states, or even intimates, that the relative diameter of the port *e* (or B) and of the graduating valve port, is in the slightest degree *essential* in the operation of the valve device.

A. I do not find in either of the descriptions referred to a
943 passage or paragraph which states or intimates that the port *e* (or B) should be of a relative size as compared with the port formed by the graduating valve.

Adjourned to meet at same place on Thursday, May 11th, 1893, at 9.30 a. m.

May 11th, 1893—9.30 a. m.

Met pursuant to adjournment.
Parties present as before.

X 226 Q. Would not the quick-action triple valves of plate IX, defendants' 1889 catalogue, and plate XI, defendants' 1891 catalogue, perform the four functions recited in the first paragraph of your answer 9, to wit: "1st, admitting air from the main air pipe to the auxiliary reservoir, ready for use; 2nd, admitting air from the auxiliary reservoir to the brake-cylinder to apply the brakes; 3rd, exhausting air from the brake-cylinder to the atmosphere to release the brakes; and, 4th, admitting air from the main air pipe to the brake-cylinder to deplete the train-pipe pressure, thereby quickening the action of the brakes on the succeeding cars, and also increasing the pressure in the brake-cylinder over that obtainable from the auxiliary reservoir," regardless of whether the port *e* (or B) of said triple valve was made *smaller* or *larger* than the graduating valve port?

I ask you this question more particularly in view of your answers to X Qs. 203 and 225.

A. They would, provided the port or passage *e* (or B) would not be made too large in reference to the passages A (or *b*), or the said ports *e* (or B) be made too small in reference to the port governed by the graduating valve.

X 227 Q. It being the case that said triple valve of defendants' 1889 and 1891 catalogues would perform the 1st, 2nd and 3rd functions recited in answer 9 and X Q. 226, regardless of whether the port *e* (or B) of said valves was made *larger* or *smaller* than the graduating port, please explain:

944 (1) Why, if at all, it is *essential*, in the operation of defendants' quick-action triple valve, plate IX, 1889 catalogue, that the port *e* (or B) should be *larger* than the graduating port, as alleged by you in answer 224?

(2) Why, if at all, it is *essential* in the operation of defendants' quick-action triple valve, plate XI, defendants' 1891 catalogue, that the port *e* (or B) should be *larger* than the graduating port?

(3) What possible utility or advantage (*other than as an auxiliary-valve device for controlling communication between the main air pipe and the brake-cylinder, in effecting a quick-action application of the brakes*) would be found in, or result from the *restriction* of the graduating port to a less diameter than that of the port *e* (or B) in the triple valves of defendants' 1889 and 1891 catalogues, and the provision of another and larger port, controlled by another valve, 22, *for the passage of reservoir air to the brake-cylinder*, in *addition* to the already existing graduating port?

A. It is *not* the case that the said triple valve of defendants' 1889 and 1891 catalogues, would or could perform the 1st, 2nd and 3rd functions recited in answer 9, if the port *e* (or B) was smaller than the port governed by the graduating valve. In my answer 226 I stated they could *provided* the port *e* (or B) would not be made too small in reference to the port governed by the graduating valve; meaning, of course, that the port *e* (or B) could be made smaller or larger so long as it was *larger* than the port governed by the graduating valve. The necessity of having the port *e* (or B) larger than the port governed by the graduating valve will be clear in my answers to sections 1, 2 and 3 of your question, which answers are as follows:

Pertaining to part (1). It is absolutely essential that the port *e* (or B) be made larger than the port governed by the graduating valve in the operation of defendants' quick-action triple valve, plate IX, 1889 catalogue, because, if the port *e* (or B) was made smaller than the port governed by the graduating valve the air from
945 the valve chamber would be exhausted quicker than the air
from the port *e* (or B) could be supplied to the chamber, thereby reducing the pressure in the valve chamber below that in the main air pipe acting on the under side of the check-valve, and thus venting the main air-pipe air into the valve chamber and thereby causing the piston to move its full stroke and produce a quick application of the brake at the time when it was desired to apply the brakes by graduation.

Part (2.) As part (2) of your question is the same as part one, except that in part (1) it is "*alleged*," and in part (2) it is not alleged, my answer to part (2) is the same as to part (1).

Part (3.) As to part (3) the utility of having the port *e* (or B) larger than the port governed by the graduating valve is—that when it is desired "to fully apply the brake (not a quick action)" the air from the auxiliary reservoir can pass to the brake-cylinder in a less space of time than it could if passed through the smaller port governed by the graduating valve.

X 228 Q. Then, as I now understand you, it *is* essential in defendants' triple valves of the 1889 and 1891 catalogues, that the port *e* (or B) shall be larger than the graduating port in order to effect the 1st, 2nd and 3rd functions recited in answer 9 and X Q. 226. Am I correct?

A. You are.

X 229 Q. The objection alleged by you in answer 227, of effecting a quick application of the brakes, at the time when it was desired

to apply the brakes by graduation, would not obtain or exist, would it, if the port *e* (or B) and the graduating port were of *equal* diameters?

A. It would not, with a careful manipulation of the brake; but in order to insure the "quick action" not taking place when graduating, we always make the port *e* (or B) larger than the graduating port.

X 230 Q. Would not the 1st, 2nd and 3rd functions recited in answer 9 and in X Q. 226 be performed by the quick-action triple valve of defendants' 1889 and 1891 catalogues, if the valve
946 22, and the port controlled thereby were not present in said quick-action triple valve?

A. They would; but the function of admitting auxiliary reservoir air to the brake-cylinder would only be accomplished by the graduating valve by the preliminary movement of the piston, and the quicker application of the brakes would be destroyed, as the main valve of the triple valve would be destroyed.

All of the last preceding answer subsequent to the words "they would," at the beginning thereof, objected to as not in anywise responsive to the question and an irrelevant volunteered statement.

X 231 Q. This being the case, is not the action of said valve 22 *necessarily* supplemental to, or auxiliary to, that of what you call the "graduating valve" of the quick-action triple valve of defendants' 1889 and 1891 catalogues?

A. No; it is not necessarily so, because the graduating valve could be constructed so that it would admit the main air-pipe air to the brake-cylinder. In experiments I have made I have used one valve to perform the graduating function, the main-valve function and the quick-action function.

X 232 Q. It is the fact, is it not, that in defendants' quick-action triple valve (plate XI, defendants' 1891 catalogue), the valve 17, 18, can be moved or operated to perform the 1st, 2nd and 3rd functions recited in answer 9 and X Q. 226, without moving or operating the valve 22?

A. It is; but in performing the 2nd function it would be of the graduating nature.

All of the last preceding answer subsequent to the words "It is," at the beginning thereof, objected to as not in anywise responsive to the question, and an irrelevant volunteered statement.

X 233 Q. It is also the fact, is it not, that the valve 22 con-
947 trols or governs communication between the main air pipe and the brake-cylinder, and that said valve 22 is actuated by the piston stem of the triple valve?

A. As to the first part of your question it is true when the partition formed by the *bushing* 9 exists in the valve structure, and it is also true that the port governed by the valve 22 also governs the passage of air from the auxiliary reservoir when the piston makes its final movement; as to the second part of your question, it is true.

So much of the last preceding answer as relates to the first part of the question objected to as embodying a qualification which is neither stated nor implied in the plain terms of the question, and as further embodying an irrelevant volunteered statement.

X 234 Q. It is also *absolutely* and *unqualifiedly* the fact, is it not, that the valve 22, of the quick-action triple valve, shown and described in plate XI, defendants' 1891 catalogue, and the descriptive matter relating thereto, controls or governs communication between the main air pipe and the brake-cylinder?

A. It is true; and it is also true that the said valve 22 is never opened for a quick action unless the auxiliary reservoir air passes to the brake-cylinder through the same valve 22.

All of the last preceding answer subsequent to the words "It is true," at the beginning thereof, objected to as not responsive and an irrelevant volunteered statement.

X 235 Q. It is the fact, is it not, that Defendants' Exhibits B and C and drawing No. 10, of Defendants' Exhibit Illustrative Cuts, in which exhibits you say: "I have arranged with the partition and differential passages of the defendants' quick-action triple valve, the slide and graduating valve mechanism of the Westinghouse patent No. 220,556,"—differ from said patent in the particular that the port of said exhibits marked C., "To brake cylinder," in drawing No. 10, is proportionately more than *twice* as large as the port C of patent 220,556?

948 A. It is.

Counsel for complainants states that, as at present advised, he now terminates the cross-examination of Mr. Boyden.

The redirect examination of Mr. Boyden and his recross-examination, if any, are postponed by consent of counsel, it being understood and agreed that the examination-in-chief of Mr. Joseph B. Church shall now be proceeded with (reserving the right of objection to counsel for complainants, who desires to return temporarily to Pittsburg), and that counsel for complainants shall not be called upon to cross-examine Mr. Church nor to attend the further examination of Mr. Boyden, prior to Tuesday next, 16th instant, and that, if the direct examination of Mr. Church shall not be concluded by that time, counsel for complainants shall be so notified by wire, and notified when his presence will be desired.

NOTE.—The testimony of George A. Boyden is continued after the testimony of Joseph B. Church.

JOSEPH B. CHURCH, a witness produced on behalf of the defendants, having been duly sworn, deposes, in answer to interrogatories, and says as follows:

Q. 1. State your name, age, residence and occupation.

A. Joseph B. Church; 40; Washington, D. C., attorney, solicitor and expert in patent causes.

Q. 2. As you are to be examined as an expert, state your qualifi-

cations to testify in that capacity, and especially with reference to air-brake patents and apparatus.

A. For the past twenty-one years I have devoted my attention exclusively to the subjects of inventions, mechanics and patents.

In the year 1872, I entered the Patent Office, where I re-
949 mained for eleven years, occupying the several positions of assistant examiner, principal examiner and examiner of interferences, which latter office I held at the time of my resignation in August, 1883. During the entire eleven years of my employment in the Patent Office, my duty required me to examine and pass upon questions of novelty, patentability and invention arising in the course of the examination of applications for patents, as well as the consideration, study and understanding of many thousands of patents pertaining to almost all branches of the mechanical arts. Since 1883, I have been engaged actively in the practice of my profession, and during that time have examined many thousands of patents, prepared and prosecuted applications for patents and furnished opinions concerning the scope and validity of patents, as well as of the alleged or possible infringements of patents. I have frequently been called upon to, and have, given evidence in patent causes, as an expert, both in this country and in Canada. I have frequently had occasion to examine patents pertaining to air and other brake mechanisms, and during the past two years have devoted considerable time to study of the subject, particularly with reference to air-brake patents and apparatus, and have been present and participated in a large number of air-brake tests and experiments conducted or superintended by Mr. George A. Boyden, at the works of the Boyden Brake Company here in Baltimore.

Q. 3. Are you familiar with the several patents and paper exhibits introduced in evidence in this cause?

A. I believe I am.

Q. 4. Have you examined, and do you understand, the various models and mechanical structures heretofore introduced in evidence in this cause?

A. I have examined and believe I fully understand the various models and mechanical structures heretofore introduced in evidence on behalf of the defendants, but have not examined complainants' exhibits, although I believe I am familiar with the structures they represent.

950 Q. 5. Explain to the court, in a general way, the system which has become known as "the automatic air-brake" system.

Objected to as incompetent, the witness not having been shown to have received any technical education, nor to have had any practical training or experience, either in that branch of the mechanic arts which relates to automatic air brakes, or in any other branch thereof, and being, by his own admission, a mere *student*, and not, in any sense of the words, a practical mechanic, mechanical engineer, or mechanical "expert."

This objection is continued, without further notice, as to the entire line of examination of the witness as an expert.

A. The automatic air brake is one of a class of brake mechanism known as "continuous," in that each car of a train is equipped with its own special brake-actuating devices, and the several brake-actuating devices of a train are so connected or united that the entire series may be operated together, and the brakes applied to all the cars comprising the train.

As the name indicates, air is the motive power employed in this system for effecting the application and release of the brakes, and as there are two or more distinct varieties or classes of air brakes, the word "automatic" is employed to designate that particular class in which special provision is made for automatically effecting the application of the brakes to a car when it becomes accidentally detached or uncoupled from the balance of the train, or when the conduit through which fluid pressure is supplied to the series of brake mechanisms is ruptured or otherwise accidentally impaired.

One of the essential distinctions between what is known as the "straight-air" or non-automatic air brake, and the "automatic" air brake, is the capacity of the latter for automatically effecting the application of the brakes to a car when the latter becomes detached or the train broken in two, and this feature or capacity
951 for automatic action is due to the difference in the principle upon which the motive power is supplied and utilized both in applying and releasing the brakes.

Adjourned to meet at same place Friday, May 12th, 1893, at 10 o'clock a. m.

10 O'CLOCK A. M., *May 12th*, 1893.

Met pursuant to adjournment.

(Mr. CHURCH resumes:)

A. In the non-automatic or straight air-brake system, the air pressure for actuating each brake piston is transmitted from the locomotive through a train-pipe; and delivered directly into the brake-cylinders of the several cars where it becomes active in applying the brakes. To release the brakes, the pressure of air in the train-pipe is relieved. When a car is detached from the air compressor, which furnishes the power for actuating the pistons in applying the brakes, no means are afforded for arresting the detached car or cars.

In the automatic air-brake system, a very different principle is introduced. In this, each car is provided with an independent reservoir for the storage of compressed air, delivered through the train-pipe, the air thus stored being employed for applying the brakes; and the admission of the reservoir air to the brake-cylinders in applying the brakes, is effected through a reduction of pressure in the train-pipe while the discharge of air from the brake-cylinder, to release the brakes is effected by restoring the pressure in train-pipe. In this system, "the automatic air-brake system," the train-pipe serves as the conduit through which the reservoirs under each

car are charged with air pressure, and so long as the maximum pressure is maintained in the train-pipe, the brakes are held off; but when the pressure in the train-pipe is lowered or withdrawn, either intentionally or by accident, the connection between the train-pipe through which the reservoir was charged is automatically closed, the exhaust from the brake-cylinder to the atmosphere is closed,
952 and communication between the reservoir and the brake-cylinder is opened, so that the compressed air in the reservoir expanding into the brake-cylinder will effect the application of the brakes.

The mechanism through which this result or effect is produced and made possible is known as a "triple valve," for the reason that it is arranged to control or effect three distinct lines of communication, one between the train-pipe and reservoir, through which the reservoir is charged with air under pressure; a second between the brake-cylinder and the atmosphere, through which the air is exhausted or allowed to escape when the brakes are released; and a third between the auxiliary reservoir and the brake-cylinder, through which the air is conducted for actuating the brakes.

The essential elements of the automatic air-brake system, so called, are the following:

1st. An air compressor or source of air supply, usually located upon the engine, and comprising an air pump and main air reservoir.

2nd. A main air or train pipe, formed in sections, of which each car is provided with one section, and the several sections are adapted to be connected in series to form a continuous conduit, whose rear end is closed.

3rd. Means for opening and closing communication between the source of air supply and main air or train pipe, and between the latter and the atmosphere for controlling the pressure of air in the main air or train pipe, such means being commonly known as the engineers' valve.

4th. A reservoir, termed an "auxiliary reservoir," on each car, in which compressed air, delivered through the main air or train pipe is received and stored, and from which the air is drawn to actuate the brake mechanism.

5th. A brake-cylinder on each car with connections for transmitting the motion and pressure of the piston to the brake-shoes.

6th. A valve mechanism termed a "triple valve" con-
953 nected to the main air or train pipe, the auxiliary reservoir and the brake-cylinder, and controlling the flow of air from the train-pipe to the auxiliary reservoir, from the auxiliary reservoir to the brake-cylinder, and from the brake-cylinder to the atmosphere.

There are various forms and modifications of the automatic air-brake mechanism, but the system I have described is the one best known and generally used in this country. Its characteristic features are the delivery to and storage upon each car of a supply of air under sufficient pressure to actuate the brake mechanism; the maint*ai*nance of the supply of air in the auxiliary reservoirs, and

the holding of the brakes released by the pressure of air in the train-pipe; the controllable application of the brakes by a reduction of pressure in the train-pipes, when such reduction is produced and controlled by the engineer; and the automatic application of the brakes by the accidental reduction of pressure in the train-pipe caused by accident or imperfections such as would affect the proper operation of the brake mechanism as a whole.

An example of what I have termed the straight-air or non-automatic system is to be found in patent No. 88929, granted to G. Westinghouse, April 13th, 1869; and in patent No. 124,404 to the same party, and dated March 5th, 1872, is illustrated one of the earliest forms of the automatic features of the air-brake system, applied in connection with the "straight-air" or non-automatic system, that is to say, it exhibits an air-brake mechanism in which the application of the brakes is effected primarily and usually by the introduction of air under pressure from one train-pipe, and, in addition thereto, an auxiliary reservoir, supplied with air through a second air pipe, is provided for each car, with suitable valves, to be brought into action when the car is derailed or separated from the balance of the train, for automatically effecting the transmission of air from the auxiliary reservoir into the brake-cylinder, and thus effect an automatic application of the brakes.

954 In the full development of the automatic air-brake system, the "straight" or direct application of pressure to the brake-cylinders through the train-pipe was omitted, and the auxiliary reservoir air alone was employed for charging the brake-cylinders, the application and release of the brakes being effected through the medium of the triple-valve mechanism and variations of pressure in the train-pipe.

Q. 6. Explain the important steps in the evolution of the "triple valve," in the air-brake art, down to the date of patent 360,070 here in suit.

A. The triple valve constituted one of the most essential and distinguishing features of what is known as the automatic air-brake system, it being the element responsive to the fluctuations of pressure in the main air or train pipe (for convenience I shall hereafter use the term "train-pipe" alone to designate the pipe or conduit through which air is transmitted from the compressor or source of supply to the brake mechanism of each car) and operating to control the admission of train-pipe air to the auxiliary reservoir, the admission of auxiliary reservoir air to the brake-cylinder, and the escape of air from the brake-cylinder.

In its earliest and most primitive form, the triple valve was composed of a casing containing a piston chamber or cylinder; a piston, three valve devices, and four connections or passages, one leading to the train-pipe, a second to the brake-cylinder, a third to the auxiliary reservoir and a fourth to the atmosphere. The form and arrangement of the several parts varied greatly, but the general construction was the same, and the operations performed were substantially identical.

The piston was subjected to two opposing air pressures, that is to

say, the piston chamber communicated at one end with the train-pipe, and at the other or opposite end with the auxiliary reservoir.

One valve controlled a passage leading from the train-pipe side of the piston to the auxiliary reservoir, and the arrangement was such that this passage would be opened when the piston,
955 under the influence of train-pipe pressure, was at one extreme of its movement, so that train-pipe air would pass into the auxiliary reservoir, raising the pressure in the latter to that in the train-pipe. This feed-opening between train-pipe and auxiliary reservoir was closed at the beginning of the return stroke of the piston, thus preventing the return of air from the auxiliary reservoir into the train-pipe.

Another of the three valve devices mentioned controlled the passage between the brake-cylinder and the atmosphere, and it was arranged to open said passage when the piston was forced out or away from the train-pipe end of its cylinder, and while the feed-opening into auxiliary reservoir was uncovered or opened. Thus with train-pipe air at maximum pressure, the piston would be operated to uncover the feed-opening into the auxiliary reservoir, and, at the same time, open the exhaust from the brake-cylinder.

The third valve device, controlling the passage from the auxiliary reservoir to thebrake-cylinder, was opened only when the piston was retracted or drawn towards the train-pipe end of its cylinder or chamber, and after the feed-opening into auxiliary reservoir and the exhaust opening from brake-cylinder had been closed, so that air from the auxiliary reservoir would flow into the brake-cylinder and effect the application of the brakes.

The movement of the piston to effect these several changes in the relations of the valve devices was produced by variations of pressure on its opposite faces, one face being subjected to train-pipe pressure, and the other to auxiliary reservoir pressure, and the direction of motion of the piston depended upon the preponderation of pressure on either face. Thus, if the pressure exerted by train-pipe air on the piston exceeded that of the auxiliary reservoir air, the piston would be moved away from the train-pipe side, opening the escape port or passage of the brake-cylinder, to release the brakes and opening the feed port or passage, to charge the auxiliary reservoir. If, now, the pressure of air in the train-pipe was reduced below that in the auxiliary reservoir, the piston would be
956 forced towards the train-pipe side and effect the application of the brakes by closing communication between the brake-cylinder and the atmosphere, and opening communication between the auxiliary reservoir and brake-cylinder.

Illustrations of triple valves such as I have referred to, but each differing in minor details of construction, are found in the following patents:

No. 141,685, granted to G. Westinghouse, Aug. 12, 1873.
No. 144,006, " " G. Westinghouse, Oct. 28, 1873.
No. 166,386, " " W. D. Jones, Aug. 3, 1875.
No. 166,405, " " H. L. Perrine, Aug. 3, 1875.
No. 168,359, " " G. West'gh'se, Jr., Oct. 5, 1875.

The last-named patent (No. 168,359) may be taken as illustrating one of the most improved forms of the triple valve as it existed in 1875.

It was not at all times required, nor desirable, when making an application of the brakes, to apply them with the full power of the auxiliary air, such as would necessarily result from a considerable reduction of pressure in the train-pipe, and the consequent full opening of the passage between the auxiliary reservoir and the brake-cylinder. This action necessarily took place when the automatic feature was brought into play, as when the train broke in two, or the train-pipe was ruptured; and when it was required to stop the train in the shortest possible time, as in an emergency. For ordinary stops and when slowing down, as on a downgrade, it was desirable that only a moderate degree of braking force be exerted, and that this might be controlled from the engine; hence provision was made whereby, by a relatively slight reduction of pressure in the train-pipe, the triple valve would be actuated to admit a limited amount of air from the auxiliary reservoir, and upon the pressure on auxiliary reservoir side of piston being diminished by expansion into the brake-cylinder, the piston would move to close the passage between auxiliary reservoir and brake-cylinder without, however, moving sufficiently to open the exhaust
and feeding passages. When a limited amount of pressure
957 had thus been developed in the brake-cylinder it could be
retained or augmented at will.

This operation of applying the brakes with less than maximum power, or by an intermitting action, is known as "graduating," to distinguish it from the automatic or full application of the brakes in the shortest possible time and with the maximum power, as in making an emergency stop.

The triple valve of patent 168,359, dated October 5, 1875, is provided with a piston working in a cylinder and subjected to train-pipe air pressure on one side and auxiliary reservoir air on the other. Communication between the train-pipe and auxiliary reservoir for feeding he latter is made through a small passage opening into the cylinder just below the piston, said passage being closed by the piston at the commencement of its stroke towards train-pipe. This is the feeding valve and passage.

The piston stem carries a slide-valve arranged to perform two valve functions, *i. e.* that of controlling the exhaust from brake-cylinder and controlling the passage from auxiliary reservoir to brake-cylinder.

When the train-pipe pressure is reduced the piston is forced back by the preponderating auxiliary reservoir pressure, thereby closing feed-passage and exhaust, and uncovering passage from auxiliary reservoir to brake-cylinder.

On the train-pipe side of the piston, and in line with the latter, is located a stem upheld by a spring. When the piston is retracted by a reduction of train-pipe pressure it first closes exhaust from brake-cylinder, and, before opening the passage from auxiliary reservoir to brake-cylinder, it encounters the spring-supported stem.

The further movement of the piston will be arrested until the preponderance of auxiliary reservoir air pressure is sufficient to overcome the spring, when the valve will be operated to open to a greater or lesser degree the passage between auxiliary reservoir and brake-cylinder and effect an application of the brakes.

958 As soon as the pressure of auxiliary reservoir air has been diminished below that exerted by the train-pipe air and spring combined, the piston will, by the spring, be moved back to close the passage between auxiliary reservoir and brake-cylinder, without, however, opening the exhaust, and the brakes can thus be held on with a pressure proportionate to the reduction made in the train-pipe. A further increase of pressure in the brake-cylinder can be effected by again reducing the pressure in train-pipe, the spring operating each time to afterwards shift the valve and close the induction passage to the brake-cylinder.

The spring-supported stem is useful only in "graduating," for when full pressure in shortest time for an emergency stop is required, or the triple valve is caused to exert the automatic function, it is requisite that the piston should be given its full stroke and held so that the main valve will fully uncover or open the passage from auxiliary reservoir to the brake-cylinder.

The next important improvement that I will notice was designed to facilitate the closing of the feed-passage by the first motion of the piston, and before the valve controlling the passage between the auxiliary reservoir and the brake cylinder was started. It is illustrated in patent No. 172,064, granted to G. Westinghouse, Jr., January 11, 1876, and consists in locating the valve between shoulders on the piston stem, so as to permit of a limited motion of the piston before engaging the valve. The independent motion allowed the piston is sufficient for closing the feed-port and preventing the auxiliary reservoir air from flowing back to the train-pipe when the pressure in the latter is lowered, as in effecting an application of the brakes.

The triple valve arrived at full development when it assumed the form and construction illustrated and described in patent No. 220,556, October 14, 1879, and so far as I am advised, this patent discloses the "triple valve" most commonly known and used at and prior to the date of patent 360,070.

959 In the general features of construction the triple valve of patent 220,556 accord in all particulars with patents 168,359 as improved in patent 172,064; that is to say, the casing with its piston chamber, valve chamber and air passages is the same, as is also the stem and its spring (denominated the "graduating spring"), the feeding valve and the main valve, the latter arranged to be engaged by shoulders on the piston stem, as in patent 172,064.

The invention and improvement of this patent (No. 220,556) consist in the addition of what is termed in the patent "an auxiliary valve," controlling a passage between the auxiliary reservoir and brake-cylinder for performing a portion of the functions previously performed by the main valve, *i. e.*, those incident to graduation.

This auxiliary valve is located within a passage in the main valve

to which it is auxiliary, and it is connected to move with the piston, whereby it is permitted a slight motion independent of the main valve, the latter remaining stationary until engaged by one of the shoulders on the piston stem.

The passage in the main valve controlled by the auxiliary or "graduating" valve, as it is termed, opens at one end into the valve chamber and terminates at a point on the face of the main valve below the upper edge thereof, and in line with the passage leading to the brake-cylinder.

Although in the patent the added element by which "a portion of the functions" previously performed by the main valve is described as "an auxiliary valve," I shall hereinafter refer to it as the "graduating valve," by which name it has since been generally known.

The operation of the improved triple valve of this patent I understand to be as follows:

When operated automatically or in effecting an emergency stop, that is, applying the maximum pressure in the shortest possible time, the new graduating valve was not brought into effective action, the main valve H performing its usual functions of
960 uncovering port C, and permitting a free passage for auxiliary reservoir air to the brake-cylinder. This operation is performed precisely as with the triple valves of patents 168,359 and 172,064, and results whenever the pressure in train-pipe is reduced to such a degree that the piston will make its full stroke towards the train-pipe end of the cylinder.

The graduating valve is only brought into action for effecting a graduated application of the brakes, and in so doing it performs those functions of the main valve H of the prior patents which related to graduating, *i. e.*, the intermitting or gradual increase of pressure in the brake-cylinder.

When the pressure on the train-pipe side of the piston is slightly reduced, so that the piston will respond to the difference of pressure on the auxiliary reservoir side, the main valve H is brought down until the motion of the piston is arrested by contact with the graduating stem, at which point the port *s'* in valve H will stand partially or wholly in communication with port C leading to the brake-cylinder, and the graduating valve having been opened at the beginning of the stroke of the piston before the upper shoulder engaged the main valve, an open passage is formed through which auxiliary reservoir air is conducted to the brake-cylinder and there operates to apply the brakes.

4.30 p. m.—Adjourned to meet at same place at 10 o'clock a. m., May 13th, 1893.

SATURDAY, *May 13th*, 1893—10 o'clock a. m.

Met pursuant to adjournment.

(Mr. CHURCH, continuing:) As soon, however, as the pressure of auxiliary reservoir air in piston chamber is reduced (by expansion in the brake-cylinder) below pressure of train-pipe air, the piston

will move slightly, to close graduating passage, but without shifting the main valve, and the brakes will be held on.

To increase the pressure in brake-cylinder by graduation,
961 the pressure in train-pipe is again lowered, when the graduating valve will be again unseated and air fed to the brake-cylinder until the reduction of pressure on auxiliary reservoir side falls below train-pipe pressure, when the graduating valve will again close. Thus by gradual and periodical reductions of pressure in train-pipe, the pressure in brake-cylinder is controlled—a result previously effected through the medium of the main valve alone—but, in the present instance, with much greater certainty and delicacy of adjustment, owing to the fact that the graduating valve alone has to be moved instead of the main valve after the latter has been first brought into position.

By the addition of the graduating valve to perform the operations of opening and closing communication between the auxiliary reservoir and the brake-cylinder, in making graduated applications of the brake, the functions of the main valve H were diminished in part, but not entirely suppressed, for it still continued to be the effective means *for applying full reservoir pressure in the shortest time*, by opening a direct passage to the brake-cylinder.

The valve mechanism controlling the passage of auxiliary reservoir air to the brake-cylinder is here divided into two parts, one being brought into action when graduating, and the other when making an emergency stop or an automatic application of the brakes.

In thus attributing to the main valve H the function and operation of the corresponding valve of the earlier structures, I have not overlooked the fact that no specific description is given in the patent (220,556) of the operation performed when an *emergency* or automatic application of the brakes is to be effected; but I have not the slightest hesitation in stating it as my opinion and understanding that such is the case, for the following among other reasons:

In the first place, the mechanism of the patent is substantially the same as that of patent No. 172,064, with the exception of the added "graduating valve," and it is arranged and adapted to perform all the operations of the prior triple valve, with the
962 single exception that the graduating function of the main valve is transferred to the graduating valve.

In the second place, the structure of the triple valve shown is such that a considerable reduction of pressure on the train-pipe side of the piston, or the withdrawal of all pressure on that side, must of necessity cause the piston to retract the graduating stem, thus carrying the main valve beyond the graduating position and causing it to make a full stroke, which would uncover the port C leading to the brake-cylinder and apply full reservoir pressure in the shortest space of time.

In the third place, the graduating valve is not described as supplanting the main valve H in controlling the passage of air from auxiliary reservoir to the brake-cylinder, but merely as performing "a portion of the functions" of said main valve as previously used,

and the only portion of the functions thus performed are such as are incident to "graduating" and not to *full* pressure.

In the fourth place, the valve H is denominated "the main valve," and the graduating valve "an auxiliary valve," by which I understand is intended to be meant *auxiliary* to the main valve in controlling the flow of air to the brake-cylinder.

In the fifth place, the description of the operation of the device is limited to the improvement effected by the transference of the graduating functions of the main valve to the graduating or "auxiliary valve."

In the sixth place, in all patents and publications in which the operation of this improved triple valve is described, so far as I have been able to find, it is generally recognized and accepted as performing the two classes of operations involved in making graduated and full, or emergency stops, the first through the medium of the graduating valve, and the second through the medium of the main valve uncovering the port C leading to the brake-cylinder. Thus, in the Westinghouse patent No. 235,922 of December 28, 1880, the triple valve of patent No. 220,556 is shown, and in describing its operations, it is said that by the shifting of main valve H, the latter is caused "to uncover the port C." In the Knee-
963 land patent No. 251,383, of October 26, 1886, in which the triple valve of patent 220,556 is shown in connection with other improvements, its action when used "to apply the brakes with their full force" is said "to permit air to flow directly from the auxiliary reservoir A′ into brake-cylinder A 2″, in contradistinction to the flow of the auxiliary reservoir air through the graduating passage in the main valve, when operated "to apply the brakes gently." Again, in the description of the triple valve of patent 220,556, contained on pages 10 and 11 of complainants' 1886 catalogue, under the title "triple valve, reservoir and cylinder," the following description is found:

"To apply the brakes with their full force the compressed air in the main brake-pipe is allowed to escape when the greater pressure in the auxiliary reservoir forces the piston 5 down below the feeding groove, thus preventing the return of air from the reservoir to the brake-pipe. As the piston descends it moves with it the slide-valve 6, so as to permit air to flow directly from the auxiliary reservoir into the brake-cylinder, which forces the pistons out and applies the brakes. The brakes are released by again admitting pressure into the main brake-pipe from the main reservoir, which pressure being greater than that in the auxiliary reservoir, forces the piston 5 back to the position shown in the drawing, recharges the reservoir, and at the same time permits the air in the brake-cylinders to escape. To apply the brakes gently, a slight reduction is made in the pressure in the main brake-pipe, which moves the piston down slowly until it is stopped by the graduating spring 9; at this point the opening *l* in the slide-valve is opposite the port *f*, and allows air from the auxiliary reservoir to feed through a hole in the side of the slide-valve and through the opening *l* into the brake-cylinder. The passage *l* is opened and closed by a valve 7,

which is attached to and moves with the piston 5, provision
964 being made for a limited motion of these parts without
moving the valve 6. When the pressure in the auxiliary reservoir has been reduced, by expansion in the brake-cylinder, until it is the same as the pressure in the main brake-pipe, the graduating spring pushes the piston up until the small valve 7 closes the feed-opening *l*. This causes whatever pressure is in the brake-cylinder to be retained, applying the brakes with a force proportionate to the reduction of pressure in the brake-pipe."

On pages 38 to 40, inclusive, of the same catalogue, in describing the construction and operation of the engineers' brake-valve, namely, the valve on the engine by which the engineer controls the application and release of the brakes, directions are given for effecting the two classes or kinds of brake-application above referred to, the one involving the sudden application of the brakes with full power by a rapid or total reduction of pressure in the train-pipe, and the other involving the gradual application of the brakes, as in graduating or making ordinary stops, this latter being effected by the gradual and partial, or intermitting, reduction of pressure in the train-pipe.

I have also in my hand another book purporting to be issued by the complainant company, entitled "Instruction Book," and bearing imprint date 1886. As indicating the scope and purpose of this work, I quote the following from the preface:

"Our attention has been repeatedly directed to the importance of furnishing a complete and concise description of our brake apparatus, to be placed in the hands of those who are engaged in its operation or its maintenance."

This book contains substantially the same description of the triple valve previously quoted from the catalogue of 1886, and in addition thereto the following statements, clearly indicating the two different kinds of brake-application:

"Too much importance cannot be attached to that portion
965 of the instruction stating that engineers should use care and
moderation in applying the brakes for ordinary stops. By applying them at a fair distance from the station, with moderate force, the train is stopped gently and without inconvenience to the passengers, while if they are thrown on with the utmost force possible, the train is jerked in a manner that is extremely disagreeable to the passengers."

The triple valves of both the 1886 catalogue and the 1886 instruction book are the same as the triple valve of patent No 220,556.

To summarize the development of the triple valve as I have outlined it, and starting with patent 168,359 containing the piston, graduating stem, feed-valve, exhaust valve, and a main valve, the latter operating to effect both graduated and full applications of the brake accordingly as the train-pipe pressure was reduced slightly or considerably, the first step of any consequence in its further development was the provision for a limited movement of the piston independently of the main valve, shown in patent No. 172,064, of January 11, 1876, and the subsequent addition of an "auxiliary"

to the main valve for performing part of the functions of the latter, to wit: those incident to graduating, as explained in patent No. 220,556, of 1879.

I may here remark that in applying the graduating valve to the main valve, as in patent 220,556, two valves are in fact introduced for effecting graduation; thus the port s' in main valve H co-operates with the port C to open and close communication between the auxiliary reservoir and the brake-cylinder, while the graduating valve e' serves to open and close communication between the auxiliary reservoir and said port s'. Both valves must be open simultaneously to effect the admission of auxiliary reservoir air to the brake-cylinder, and if either is entirely closed auxiliary reservoir air will be prevented from passing through the graduating devices to the brake-cylinder.

The function of opening and closing the escape from the
966 brake-cylinder to the atmosphere is performed by a part of
the main valve, as in the prior patents referred to.

Q. 7. Explain what is known in the air-brake art as "quick action;" the reason why quick action is desirable, and the important steps in the evolution of "quick action" down to the date of patent No. 360,070, here in suit.

A. The term "quick action" as applied to air brakes, is, as I understand, employed in a general way to designate a system in which the application of the brakes on all the cars composing the train is effected simultaneously, in the shortest possible time and with the maximum braking force, but it has more recently been adopted to specifically define an automatic air-brake system in which provision is made for venting the train-pipe at intervals in its length, in order that train-pipe pressure may be quickly reduced throughout the entire length of the train-pipe, and the triple valves be caused to act simultaneously, or as nearly so as possible, to apply the maximum braking force upon each car composing the train. The *quick-action* operation is brought into play only in cases of emergency, when a sudden stoppage of the train is rendered necessary. The quick action referred to corresponds generally with the full pressure or emergency stop of the old forms of automatic-brake appliances, and is distinct from the operations of graduating and making service stops.

In operating the old automatic air-brake system, the train-pipe pressure was depleted or exhausted by the opening of an escape port or valve, on the engine; hence, to effect such a reduction of pressure as was necessary to produce the full stroke of the triple-valve piston and a full application of the brakes, the air had to travel from the rear end of the train-pipe to the engine. The movement of the air in the train-pipe was comparatively sluggish, but sufficiently rapid on relatively short trains to not injuriously affect the braking action; but when it was attempted to apply the automatic air-brake system to relatively long trains of cars, say forty or fifty
cars, it was found that the interval between the time of appli-
967 cation of the first and last brakes was so great as to result in
the production of disastrous shocks, due to the fact that the

brakes were applied progressively from the front of the rear of the train, the front cars being quickly arrested and the rear cars running at full speed colliding with those in front before the brakes on said rear cars were brought fully into action. The defect in this particular was not due to the "triple valves," as these were adapted to quickly respond to a sudden reduction of pressure in the train-pipe, but the difficulty was in the way of producing the requisite degree of reduction simultaneously throughout the entire length of the train-pipe so that the several triple valves would be brought into action simultaneously.

Numerous schemes were devised for overcoming this defect in the old automatic air-brake system when applied to long trains, and some of them contemplated the opening of escape ports located at intervals in the length of the train-pipe, the operations necessary to open and close said serial vents being performed by the movement of the air in the train-pipe.

As illustrating one way by which the reduction of pressure throughout the length of the train-pipe is accelerated, I will refer to patent No. 217,838 granted to G. Westinghouse, Jr., July 22, 1879, wherein is shown and described what is termed an "automatic brake relief valve" adapted for insertion at various points in the length of the train-pipe, and to be operated by a reduction of train-pipe pressure, to open a vent or escape port. These relief valves are located at intervals in the train-pipe, preferably at the couplings between the cars, and they are caused to operate successively whenever the pressure is considerably reduced in the forward end of the train-pipe, that is to say, when the engineers' valve is operated to reduce the pressure in the train-pipe, the first relief valve is operated to open an escape port or vent, through which latter the air escapes from the following section of the train-pipe, and the reduction of pressure thus effected actuates the second relief valve to cause the depletion of the train-pipe air in the next sec-
968 tion, and so on throughout the length of the train. By this means a series of discharges of train-pipe air was effected instead of a single discharge through the engineers' valve, and instead of requiring that the air should flow from the extreme rear end of the air pipe to the engineers' valve, numerous vents were provided for the escape of train-pipe air. In other words, each relief valve discharged train-pipe air from its particular section, thereby not only causing the actuation of the triple valve, but also the next succeeding relief valve.

This illustrates the most advanced stage in "quick action" as applied to the old automatic air-brake system, involving the triple valve, with which I am acquainted.

There were other forms of quick-action brake appliances in which air was employed as a motive power, and supplied to auxiliary reservoirs through a train-pipe, but instead of the triple valve operated by variations of pressure in the train-pipe to apply and release the brakes, electrically operated valves were employed, electricity being used for effecting a simultaneous action of all the brakes.

Adjourned at 4 p. m., to meet at same place on Monday, May 15th, 1893, at 10.30 a. m.

10.30 A. M., MAY 15TH, 1893.

Met pursuant to adjournment.

Q. 8. Explain the construction and operation of the mechanical device or combination constituting the "quick-action" device, described and shown in the patent No. 360,070, here in suit, and specified in the 1st, 2nd and 4th claims thereof.

A. The alleged invention of the patent referred to is denominated an improvement in "fluid-pressure automatic brake mechanism," and is designed to produce a serial quick action of the triple valve and of the brakes by a discharge of air from or venting of
969 the train-pipe at different points in the length of the latter, thereby hastening the reduction of pressure in the train-pipe, and in addition thereto utilizing the air whose discharge effects a reduction in the pressure of train-pipe air by conducting it into the several brake-cylinders, instead of discharging it into the atmosphere.

As a whole, the automatic brake mechanism of this patent is identical with that previously in use and described in patent No. 220,556, with one slight modification in one of the parts of the "triple valve," and the addition of an auxiliary-valve device, through the medium of which latter the air is discharged from the train-pipe directly into the brake-cylinder and independently of the triple valve proper, to effect the result termed "quick action."

The auxiliary-valve device is arranged to be operated by the piston of the triple valve proper as previously used. Before explaining the additional members constituting this auxiliary-valve device, I will briefly explain the automatic air-brake system in use prior to said patent No. 360,070, and with which the new device of said patent is combined.

As before stated, the automatic air-brake equipment is the same as, and includes, the triple valve of patent No. 220,556; that is to say, it includes an air compressor, main air reservoir and engineers' valve located upon the engine; a train-pipe in sections, each car being provided with a section; an auxiliary reservoir under each car; a brake-cylinder and brake-actuating devices under each car, and the triple valve of patent No. 220,556 controlling the passage from the train-pipe to the auxiliary reservoir, the passages through which auxiliary reservoir air is conducted to the brake-cylinder (said passages including the graduating passage in the main valve, as well as the passage controlled by the main valve alone,) and the exhaust passage from the brake-cylinder to the atmosphere.

11.15 a. m.—Mr. George H. Howard at this point appeared for complainants.

970 When the cars, separately equipped as described, are connected together to form a train, the train-pipe sections are coupled together to form a continuous conduit extending the full length of the train, the rear end of said train-pipe being closed by a valve and the front end connected with the engineers' valve.

In the absence of the new elements and functions added to the

triple valve, the operation of the entire equipment described in this patent would be the same as that of patent No. 220,556; that is to say, a slight reduction of pressure in the train-pipe would cause the piston of the triple valve to move towards the train-pipe side, closing the feeding passage leading to the auxiliary reservoir, and actuating the main and auxiliary valves to close the exhaust passage leading from the brake-cylinder to the atmosphere, and bring the graduating passage 31 wholly or partially in register with passage 23, leading to the brake-cylinder.

Under the conditions named the movement of the valve piston would be arrested by its contact with the graduating stem 36, and the flow of auxiliary reservoir air through the graduating passage would be interrupted when the pressure on auxiliary reservoir side of the piston was diminished below that on the train-pipe side by the slight movement of the piston closing valve 29 against its seat, said valve 29 being the "auxiliary valve" of patent No. 220,556 and the "graduating valve" of patent 360,070. To increase the pressure in brake-cylinder graduating operations are repeated; and to release the brakes the pressure in train-pipe is restored.

When, however, the pressure in train-pipe was suddenly and considerably reduced, either by the engineer or automatically, by the breaking of the train or the bursting of the train-pipe, the preponderance of auxiliary reservoir air pressure upon the piston of the triple valve would carry said piston, and the valve connected thereto, its full stroke, and in so doing would drive back the graduating stem and carry the graduating port 31 in main valve beyond the port or passage 23, through which latter communication was before
971 made with the brake-cylinder, thereby opening communication between the auxiliary reservoir and brake-cylinder through a passage 35 in the end of the main valve, one end of said passage opening into the valve chamber and being always in communication with the auxiliary reservoir, while the other end terminates at the face of the valve and registers with the port 23 when the valve piston is fully retracted.

The slight modification which I have mentioned as having been made in the triple valve of patent 220,556, consists in the elongation of the main valve and the introduction of the supply passage 35 through which air is conducted directly from the auxiliary reservoir to the brake-cylinder.

In patent 220,556 the main valve (lettered H in said patent) was of such length as to uncover the mouth of passage C when the valve piston made its full stroke toward the train-pipe side, while in the modified form shown in patent 360,070, substantially the same operation is performed by the end of passage 35 registering with port 23, the only difference being that in the one case auxiliary reservoir air is caused to flow past the end of the main valve into port 23, while in the other it passes through an opening or passage 35 in the end of the main valve and thence through port 23.

My conclusions concerning the construction and operation of the entire automatic air-brake system of this patent, excluding the new parts, is not alone based upon a comparison of the triple valve with

the prior triple valve of patent No. 220,556, but is in part derived from the direct admissions made by the patentee in his specification. Thus I find the following statement on page 2 of the specifications, lines 29 to 46, inclusive:

"So far as the performance of its preliminary function in ordinary braking is concerned—that is to say, effecting the closure of communication between the main air pipe and the auxiliary reservoir and the opening of communication between the auxiliary
972 reservoir and the brake-cylinder in applying the brakes, and
the reverse operation in releasing the brakes—the triple valve 10 accords substantially with that set forth in letters patent of the United States No. 220,556, granted and issued to me October 14, 1879, and is not, therefore, saving as to the structural features by which it performs the further function of effecting the direct admission of air from the main air pipe to the brake-cylinder, as presently to be described, claimed as of my present invention."

Referring to the "triple valve proper" and its construction, it is said, page 2, lines 60 to 69, inclusive:

"The triple-valve case is fitted with a cylindrical sleeve or bushing 11, which is bored out truly and forms the chamber of a piston 12, which is fixed upon a stem, 13, carrying, as in my letters patent No. 220,556, before mentioned, a slide-valve, 14, which controls communication between the auxiliary reservoir and the brake-cylinder and between the brake-cylinder and release port 15, respectively."

In the description of the modification to which I have referred, no mention whatever is made of any new or additional functions performed by the passage 35, said passage serving only to establish direct communication between the auxiliary reservoir and brake-cylinder, as was previously done by the end of the main valve. The description of this passage 35 is found on page 3, lines 4 to 19, inclusive, as follows:

"The construction and relative arrangement of the piston stem 13 slide-valve 14 and graduating valve 29 are substantially similar to those of the corresponding parts as heretofore employed by me and exemplified in my letters patent No. 220,556; but under my present invention these are supplemented by a port, 35, leading from the end of the valve adjacent to the opening of the chamber 24, which communicates with the auxiliary reservoir, to the face of the valve, so as, at the limit of traverse of the piston stem in the
973 application of the brakes, to establish communication di-
rectly through said passage between the auxiliary reservoir and the port 23 and passages 22 and 16, leading to the brake-cylinder."

I understand the *direct* communication which is described as being established through said passage 35, to be the same as the direct communication previously made by uncovering the port C of patent No. 220,556, and referred to on page 10 of complainant company's catalogue of 1886, where it says:

"As the piston descends, it moves with it the slide-valve 6 so as to

permit air to flow *directly* from the auxiliary reservoir into the brake-cylinder."

My conclusion that the introduction of the passage 35 was not intended to and does not change the operation of the device is further supported by the statement following the description of said modification on page 3, lines 39 to 43, as follows:

"So far as hereinbefore described, the triple valve accords in all substantial particulars with, and is adapted to operate similarly to those of letters patent Nos. 168,359, 172,064 and 220,556."

Recess.

I will now proceed to describe the new parts added to the old brake-equipment, and which constitute the only novel features of the brake mechanism described in patent 360,070, as is clearly set forth in the specification of the patent, wherein it is declared (page 3, lines 43 to 47) after stating that the triple valve itself and its mode of operation were the same as the prior patented structures, that

"In order that it may perform the further functions requisite in the practice of my present invention, it is provided with certain additional members, which will now be described."

The "additional members" to which reference is made in the above-quoted paragraph of the specifications, include a pas-
974 sage extending from the train-pipe side of the triple-valve
piston directly to the brake cylinder, said passage being entirely outside and independent of the triple valve proper, although formed in the same casing, a check-valve arranged in said passage and opening towards the brake-cylinder, and a slide-valve controlling the inlet end of said passage; that is to say, the end opening into the train-pipe end of the piston chamber, said slide-valve being connected to and operated by the graduating stem of the triple valve proper. The passage I have referred to as connecting the train-pipe side of the triple valve and the brake-cylinder is not shown in the patent as a straight passage, but is made up of the following parts: Its connection with the train-pipe begins at the port 42, it being understood that train-pipe air is delivered into the valve-piston chamber substantially as in prior patent 220,556. Port 42 communicates with the chamber 43 containing the check-valve 49, and from the rear of said check-valve extends the passage 46, opening into a chamber 47, and the latter communicating with the brake-cylinder through a pipe 48. These communicating passages are fully disclosed in "Defendants' Exhibit Section of Westinghouse Triple Valve of Patent 360,070 (red valve)."

I may here remark that the passage 22 of the triple valve proper through which auxiliary reservoir air is admitted to the brake-cylinder, opens into chamber 47, and that the pipe 48 forms the conduit through which air delivered from the auxiliary reservoir and from the train-pipe side of the valve piston passes to the brake-cylinder.

Considering the passage as one element, it will be seen that the "additional members" referred to in the specification of the patent, are three in number, to wit: the passage around the triple valve

proper, the check-valve 49, and the slide-valve 41, controlling port 42 at the beginning of said passage.

Now, the object and purpose had in view in the addition of these members to the old triple valve was twofold.

975 First. To provide a series of discharge openings through which train-pipe air could escape and thus more quickly effect a reduction of pressure in the train-pipe after the manner indicated in prior patent No. 217,838 of July 22, 1879; and

Secondly. Utilizing the air escaping from the train-pipe by conducting it into the brake-cylinder instead of discharging it into the atmosphere.

In so far as the first of these two actions is concerned, it would appear to be but an enlargement upon or extension of the operations performed by the device described in patent No. 217,838, July 22d, 1879, wherein it is stated with reference to the ordinary automatic brake system that

"It sometimes happens with such brake apparatus, especially in case of accident, that material advantage could be effected by having all the brakes of the train applied or brought into action simultaneously, or as nearly so as possible. To accomplish this it is only necessary to make provision for the simultaneous opening of one or more ports in the air-conduit passages at points not remote from each auxiliary reservoir."

Upon comparison, it will be found that substantially the same operation is designed to be performed by these "additional members" of patent 360,070, as appears from the following statement in the specification (page 1, line 73 to 90):

"The application of the brakes with their full force has heretofore required a discharge of air from the main pipe sufficient to reduce the pressure in said pipe below that remaining in the auxiliary reservoir after the brakes have been fully applied, and it has been found that, while the brakes are sufficiently quick in action on comparatively short trains, their action on long trains of from thirty to fifty cars, which are common in freight service under present practice, is in a measure slow, particularly by reason of the fact that all the air required to be discharged from the main pipe
976 to set the brakes must travel from the rear of the train to a single discharge opening on the engine. This discharge of air at the engine has not only involved a serious loss of time in braking, but also a waste of air."

Inasmuch as the automatic brake relief valve of patent 217,838 was designed to and did provide a series of escape ports through which air from the train-pipe could be permitted to escape, to hasten the reduction of pressure in said train-pipe, the statement quoted last above from patent 360,070 is not strictly accurate, if intended to convey the impression that the only known means for quickly reducing the pressure of air in the train-pipe was through the single discharge at the engineers' valve.

The addition of the new element to the triple valve of patent 220,556 did not in any way change or affect the operation of said triple valve, but merely added the functions pertaining to said

BLEED THROUGH POOR COPY

"additional members," that is to say: the triple valve proper performed its usual functions, both in applying graduated pressure and in opening direct communication between the auxiliary reservoir and the brake-cylinder, and the "additional members" were arranged to come into action during the last portion of the stroke of the valve piston with the following result.

So long as the valve piston is operated within the limit allowed for graduating, that is to say, until it makes contact with the graduating stem, the action of the triple valve is the same as that of patent 220,556, the valve 41 remaining over port 42, so that no air can enter the passage forming one of the "additional members."

When, however, the pressure in the train-pipe is suddenly reduced, and to a degree sufficient to cause the piston of the triple valve to retract the graduating stem and open direct communication between the auxiliary reservoir and the brake-cylinder, through passage 35 in main-valve 14, valve 41, connected to the graduating stem,
977 will be moved by the latter to uncover port 42, thus permitting train-pipe air to enter the passage, unseat the check-valve and enter the brake-cylinder, thereby assisting in depleting the train-pipe, and utilizing the air thus withdrawn by causing it to act upon the piston in the brake-cylinder. As the parts are arranged and adjusted in the patent, the port 42 is opened by the movement of slide-valve 41 slightly in advance of the opening of port 23 by the movement of the main valve, to bring passage 35 in communication with said port 23, hence the air from train-pipe entering through port 42 flows into the brake-cylinder without encountering any resisting air pressure until after port 35 is brought to uncover port 23, when air from the auxiliary reservoir will also be conducted into the brake-cylinder as in the old tripie valve of 1879. As soon as the pressure in the brake-cylinder and passage equals or exceeds the pressure in the train-pipe, which it soon does by reason of the flow of compressed air from the auxiliary reservoir into the brake-cylinder, check-valve 49 will be operated by its spring to close the passage between train-pipe and brake-cylinder, and thus prevent the escape into the train-pipe.

There being a triple valve provided with the "additional members" mentioned under each car, when the pressure in train-pipe is suddenly reduced in a moderate degree, that is to say, reduced below the point necessary for a graduated application of the brakes, and low enough to cause a full stroke of the triple-valve piston, but without entirely depleting the train-pipe, each valve 41 (termed "an auxiliary valve") will be operated to open an escape from the train-pipe, and thus relieve the pressure in the latter and hasten the action of the next succeeding triple valve.

The piston of the triple valve proper is utilized in this construction to mechanically effect the movement of the auxiliary valve 41 in opening the escape port from the train-pipe, and, as before explained, the air withdrawn from the train-pipe, instead of being discharged into the atmosphere and wasted, is conducted around
978 the triple valve and discharged into the brake-cylinder, where it is utilized to supplement the auxiliary reservoir air ad-

mitted through the triple valve proper, in effecting the application of the brakes.

4.35 p. m. adjourned to meet at same place at 10.30 a. m., May 16th, 1893.

10.30 A. M., MAY 16TH, 1893.

Met pursuant to adjournment.
Parties present as before.

I should have mentioned that the "additional members" of the patent are only brought into action in effecting an emergency stop, the latter corresponding to the emergency stop produced by the old triple valve of patent No. 220,556; and that the action in effecting such emergency stops is improved by the addition of the functions, incident to said additional members of effecting a more rapid depletion of the pressure in train-pipe, and the utilization of train-pipe air in the brake-cylinder, resulting in a more nearly simultaneous action of the several triple valves.

The fact that the "additional members" are not employed in making ordinary graduated, or service, stops is made clear by the following statements in the patent (page 3, lines 93 to 105):

"To apply the brakes in making ordinary stops, a portion of the air is discharged from the main air pipe by the engineers' valve, thereby correspondingly reducing the pressure in the main air pipe, whereupon the higher pressure in the auxiliary reservoir moves the piston 12 to the right, covering the feeding groove 51, and thus preventing the return of air from the auxiliary reservoir to the main air pipe, the movement of the piston continuing until arrested by the decrease of pressure in the auxiliary reservoir, or by the stem 36 and its spring 39."

979 Page 4, lines 6 to 13:

"The admission of air to the brake-cylinder through the passage 31, which is opened just before the piston stem comes in contact with the graduating stem, and which corresponds to the feed-passage heretofore employed, suffices for the ordinary requirements of braking in regular service."

The passage 31, referred to as the feed-passage, is what I have designated as the graduating passage controlled by the graduating valve.

That the "additional members" are only brought into action in effecting an emergency stop, and that they operate only to supplement the action of the main valve of the triple valve is indicated by the following passages in the specification (page 3, lines 47 to 57):

"For the purpose of effecting the admission of air directly from the main air pipe 2 to the brake-cylinder 7, when it is desired to apply the brakes with great rapidity and full force, an auxiliary slide-valve, 41, is connected to and moves with the stem 36, said valve working over a face in the bushing 37 between the piston chamber 11 and drain-cup 19, and governing a port, 42, in said face leading into a chamber, 43, adjoining the same."

Page 4, lines 13 to 32:

"In the event, however, of its becoming necessary to apply the

brakes with great rapidity and with their greatest available force, the engineer, by means of the valve at his command, instantly discharges sufficient air from the front end of the main air pipe to effect a sudden reduction of pressure of about twenty pounds per square inch therein, whereupon the piston 12 of the triple valve is forced to the extreme limit of its stroke in the direction of the drain-cup 19, carrying with it the stem 36 and auxiliary slide-valve 41, which instantly uncovers the port 42 and discharges air from the main air pipe through the opening of the check-valve 49 and the passages 46 and 48 to the brake-cylinder, and, each car being provided
980 with one of these devices, it will be seen that they are successively moved with great rapidity," etc.

Page 4, lines 43 to 51:

"When the piston 12 arrives at the extremity of its stroke, as above specified, the supplemental port 35 of the slide-valve 14 is brought into communication with the port 33 and passages 22 and 16, which serves to discharge the reservoir pressure into the brake-cylinder, thereby augmenting the pressure already exerted in the brake-cylinder by the air admitted from the main air pipe."

The statement last above quoted would indicate that a train-pipe air was admitted to the brake-cylinder sufficiently in advance of the admission of auxiliary reservoir air through passage 35, to produce the maximum pressure of admitted train-pipe air in the brake-cylinder before auxiliary reservoir air was delivered into the brake-cylinder, but in my opinion this is not strictly true. The auxiliary valve 41 is arranged to uncover port 42 and admit train-pipe air to the brake-cylinder, through the passage around the triple valve, slightly in advance of the admission of auxiliary reservoir air through the passage 35; and the passages and ports through which train-pipe air is conducted are relatively larger than those through which auxiliary reservoir air is conducted to the brake-cylinder; consequently the flow of train-pipe air to the brake-cylinder would precede auxiliary reservoir air, and a relatively larger volume would pass in a given time; but under the conditions of actual practice, the piston of the triple valve will move so rapidly that both passages, from train-pipe and auxiliary reservoir, will be opened instantly, and the flow of air will begin from the train-pipe only a small fraction of a second in advance of the auxiliary reservoir air.

I observe that in the drawings of patent 360,070 the passage 35 is represented as smaller in cross-section than the graduating passage 31 and the port 23 and passage 22 leading to the brake-
981 cylinder. No mention is made in the specification of this fact, nor is any function attributed thereto; on the contrary, the specification conveys an implication that the passage 35 performs the same functions as were performed by the end of the main valve of patent 220,556, in stating that the triple valve, of which passage 35 is a part, "accords in all substantial particulars with and is adapted to operate similarly to those of my letters patent Nos. 168,359, 172,064, and 220,556." In my opinion, however, if the port or passage 35 is made smaller than the port 23, as shown in the patent, it will operate to check the flow of auxiliary reservoir air into the

brake-cylinder, and thus permit a larger volume of train-pipe air to enter the brake-cylinder before it is checked by the expansion of the higher pressure auxiliary reservoir air.

I also observe that the feed-passage 31 of the graduating valve is smaller than port 23 (as is the case in patent No. 220,556), the reason for which is thus stated on page 4, lines 58 to 67:

"The feed-opening for the admission of air from the auxiliary reservoir to the brake-cylinder is purposely made of comparatively small diameter, it having been determined by experiment that the initial application of the brakes should not be made with maximum force, and this opening may be made of such size as to apply the brakes exactly in accord with the requirements of most efficient work."

I observe that throughout the specification of patent 360,070, the term "triple valve" is loosely and ambiguously employed, it being used to designate, first, the triple valve as previously known in the art and illustrated in prior patents, and, secondly, to designate the new device of the patent, including the triple valve of patent No. 220,556 as improved by the introduction of the "additional members," to wit, the passage, the check-valve, and the auxiliary valve.

As I have before explained, the term "triple valve" was in common use prior to the date of patent No. 360,070, and the valve
982 mechanism most popularly known under that title was of the form shown in patent No. 220,556. The "triple valve" of patent No. 220,556 is illustrated and described as such in patent 360,070 and is *the* triple valve said to be

"*provided with certain additional members,*"

in order that it may

"perform the further functions requisite in the practice of my present invention."

As illustrating the common use of the term "triple valve," as applied to the valve mechanism of patent No. 220,556, I refer to complainant company's catalogue of 1886 and complainant company's "Instruction Book" of 1886, and to the following patents granted to G. Westinghouse, Jr.:

No. 243,415, dated June 28, 1881, and

No. 235,922, dated December 28, 1880, and the patent to S. R. Kneeland,

No. 351,382, dated October 26, 1886.

I understand it to be in this sense, and as applying to other forms of triple valves proper (of which patents Nos. 168,369 and 172,064 are examples, although others exist,) that the following language is used in the patent under consideration (page 4, lines 68 to 85):

"In using the terms 'triple valve' and 'triple-valve device' I refer to a valve device, however specifically constructed, having a connection with the main air or brake pipe, another with an auxiliary reservoir or chamber for the storage of power, and another with a brake-cylinder, or its equivalent, for the utilization of the stored power and with a release or discharge passage for releasing the op-

erative power from the brake-cylinder, whether the valves governing these passages or connections are arranged in one or more cases and are moved by a piston, or its equivalent, or by a series of pistons or their equivalents, there being numerous examples in the art of constructions varying materially in appearance whereby these functions are performed, both in plenum and vacuum brake mechanisms."

983 I understand the term "triple valve" to be used with the second meaning, *i. e.*, triple valve proper *plus additional members*, in the following paragraph (page 1, lines 20 to 27).

"To this end my invention, generally stated, consists in a novel combination of a brake-pipe, an auxiliary reservoir, a brake-cylinder and *a 'triple-valve' device*, governing, primarily, communication between the auxiliary reservoir and the brake-cylinder; and secondarily, communication directly from the brake-pipe to the brake-cylinder."

The same meaning is given to the term in the paragraph beginning line 29, page 2, wherein it states that in performing its ordinary functions—

"*The triple valve* 10 accords substantially with that set forth in letters patent of the United States, No. 220,556, granted and issued to me October 14, 1879, and is not, therefore, saving as to the structural features by which *it* performs the further function of effecting the direct admission of air from the main air pipe to the brake-cylinder, as presently to be described, claimed as of my present invention. Certain of *its* elements devised and employed by me prior thereto, will, however, be herein specified in order to render *its* construction and operative relation to other members of the brake mechanism fully intelligible."

To briefly summarize the alleged novel elements and functions of the fluid pressure automatic brake mechanism of patent 360,070, as I understand them, they comprise the passage extending from train-pipe side of valve piston to brake-cylinder, the check-valve located in said passage and the auxiliary valve 41 controlling the admission of air to the aforesaid passage, these three elements constituting the so-called "additional members." The confessedly old devices are the entire brake-equipment, including train-pipe, auxiliary reservoir, brake-cylinder and a triple valve of the kind previously known under that name and particularly exemplified as of the form shown in patent No. 220,556.

984 As to functions, those of the ordinary triple valve are preserved without material change; that is to say, the triple valve is provided with a graduating valve, through which auxiliary reservoir air is admitted to the brake-cylinder in making graduated applications of the brake, and a second, or main valve, through the medium of which auxiliary reservoir air is admitted to the brake-cylinder when the valve piston is fully retracted, as when making an emergency or an automatic application of the brakes.

The functions of the "additional members" are, to open a port or passage communicating with the train-pipe on the train-pipe side of the triple valve proper, and thereby permit train-pipe air to escape

and thus reduce the pressure in the train-pipe, the air, as it escapes, being conducted around the triple valve proper and discharged into the brake-cylinder, where it is utilized to supplement or assist the air delivered from the auxiliary reservoir, through the triple valve proper, in effecting a full application of the brakes. The auxiliary valve of the additional members is caused to perform its office of opening the direct passage for train-pipe air to the brake-cylinder by its attachment to the graduating stem, which latter is actuated by the valve piston only when the preponderance of pressure on the auxiliary reservoir side is sufficient to overbalance the pressure exerted on the train-pipe side of the piston.

Recess.

The piston of the triple valve proper may be said to have, or be permitted, two degrees of motion within its cylinder, the one shorter than the other and limited, on the train-pipe side, by contact of the piston stem with the graduating stem; and the other a longer movement, including the first, and representing the maximum or full stroke of the piston, during which the graduating stem is retracted or pushed back by the piston.

985 During the first or preliminary movement of the piston the valve mechanism of the triple valve is operated to effect what has been explained as a graduating or service stop, and when so operating the auxiliary valve of the "additional members" is not moved to uncover the port 42, hence there is no discharge of train-pipe air into the brake-cylinder.

It is only during the last portion of the full stroke of the piston, when it opens the direct passage through port 35, that the direct passage from train-pipe to brake-cylinder is opened, and air permitted to pass to the brake-cylinder.

The question to which the foregoing is an answer, and the answer also, are objected to by counsel for complainants; the former as calling for, and the latter as assuming to give an explanation of construction and operation fully disclosed by patent No. 360,070, and a definition of the legal scope of the patent. The question and answer are objected to as incompetent, irrelevant and immaterial.

Q. 9. State what you understand to be claimed as new inventions in said 1st, 2nd and 4th claims, respectively, giving your reasons with your opinions.

Objected to as calling for an opinion in law, and as incompetent.

A. The first claim of the patent is as follows:

"1. In a brake-mechanism the combination of a main air pipe, an auxiliary reservoir, a brake-cylinder, a triple valve and an auxiliary-valve device, actuated by the piston of the triple valve and independent of the main valve thereof, for admitting air in the application of the brake directly from the main air pipe to the brake-cylinder, substantially as set forth."

I understand this claim to include the combination of the following parts or elements:

BLEED THROUGH POOR COPY

1. A main air pipe, which I have termed the train-pipe, for conveying air under pressure from a main reservoir or source of air supply on the engine to the point or points where it is to be utilized.

986 2. Means for maintaining and varying the air pressure in said main air or train pipe.

3. An auxiliary reservoir in which air is stored for subsequent use in braking.

4. A brake-cylinder with devices for actuating the brakes connected therewith.

5. A triple valve proper provided with a piston and valves controlling the admission of air from the main air or train pipe to the auxiliary reservoir, the escape of air from the brake-cylinder to the atmosphere and the admission of air from auxiliary reservoir to brake-cylinder, said triple valve being actuated by variations of pressure in the main air or train pipe.

6. An auxiliary-valve device, that is, an additional valve device auxiliary to the triple valve proper and independent of the main valve thereof; said auxiliary valve being actuated by the piston of the triple valve proper and operating to control a passage or passages connecting the train or main air pipe and the brake-cylinder in a manner to effect the admission of train-pipe air directly into the brake-cylinder, and without passing through the triple valve proper, the train-pipe air thus admitted being utilized in conjunction with the air delivered from the auxiliary reservoir through the triple valve proper, in effecting the application of the brakes quickly and with full power, and the withdrawal of air from the train-pipe serving to reduce the pressure in the latter and thereby quicken the movement of the triple-valve device on the next succeeding car.

Of the six enumerated elements, the first five are admittedly old; hence I understand the invention expressed in this claim is the combination with said old elements of the so-called "auxiliary-valve device," which latter is further described as *independent* of the main valve of the triple valve proper, and arranged to be actuated by the piston of the latter. The only device answering to the description of "an auxiliary-valve device," as employed
987 in this claim, is the valve 41, which latter is described in the specification as "an auxiliary slide-valve," and is one of the three additional members by which the invention of patent 360,070 is distinguished from the triple valve of patent 220,556, as previously employed. I understand further that the "triple valve" of this claim to which the "auxiliary-valve device" is added, may be either the triple valve shown and described in the patent, or other equivalent forms of triple valve, such triple valves performing their usual functions, that is to say, being operated to control the admission of train-pipe air to the auxiliary reservoir; to control the admission of auxiliary reservoir air to the brake-cylinder, *both* for graduating and full-pressure applications of the brake; and to control the escape of air from the brake-cylinder to the atmosphere.

Inasmuch as the auxiliary slide-valve 41 alone would be incom-

petent to effect the admission of air from the train or main air pipe to the brake cylinder, I understand the term "auxiliary-valve device" to include both the auxiliary slide-valve 41 and the passage extending from the train-pipe side of the triple valve to the brake-cylinder, said passage being another of the so-called additional members.

The second claim of the patent is as follows:

"2. In a brake mechanism the combination of a main air pipe, an auxiliary reservoir, a brake-cylinder, and a triple valve having a piston whose preliminary traverse admits air from the auxiliary reservoir to the brake-cylinder, and which by a further traverse admits air directly from the main air pipe to the brake-cylinder, substantially as set forth."

I understand this claim to include the first four enumerated elements of the first claim, and, in addition thereto, a fifth element, as follows:

5. A triple valve proper adapted to perform the ordinary functions of such a valve in effecting the admission of auxiliary reservoir air to the brake-cylinder when making a partial stroke, as in
988 graduating, and effecting a second admission of auxiliary reservoir air to the brake-cylinder by the further movement or completion of the full stroke of the valve piston, and valve device, supplemental or auxiliary to the main valve of the triple valve proper in effecting the admission of air to the brake-cylinder, said auxiliary-valve device being actuated by the piston of the triple valve proper during its final movement, and serving to open a passage from the train-pipe to the brake-cylinder.

In thus construing the claim as containing a fifth element composed of two parts, that is to say, a triple valve proper, and an auxiliary-valve device, I have not overlooked the fact that in the claim the fifth element is described as a triple valve possessing the capacity of admitting air directly from the train-pipe to the brake-cylinder; but, as I have before explained, the term "triple valve" is employed in the specification, to which the claim refers by the words "substantially as set forth," to define two structures, the one a triple valve proper, and the other the triple valve *plus* the additional members of the present patent, namely, the passage, the check-valve and the auxiliary valve; and inasmuch as the functions attributed to the triple valve of claim 2 are *not* the functions of the *ordinary* triple valve, but are those of the new valve mechanism, I have concluded that the second of the two definitions employed in the specification is the one implied in the claim.

If the term "triple valve" as employed in claim 2 means the triple valve of patent No. 220,556, (which is the triple valve proper of patent 360,070,) the combination expressed would be identical with the combination *disclaimed* in patent 360,070 and disclosed in patent No. 220,556; and said combination would be inoperative to effect the admission of air directly from the main air pipe to the brake-cylinder, inasmuch as that function is alone performed by the "additional members" which are combined with the triple
989 valve proper, and there is neither hint, suggestion nor

description in the patent of a triple valve proper by means of which, and without the addition of the auxiliary valve, train-pipe air could or would be admitted directly from the train-pipe to the brake-cylinder.

4.45 o'clock p. m., adjourned to meet at same place, Wednesday, May 17th, 1893, at 10.30 o'clock a. m.

10.30 A. M., MAY 17TH, 1893.

Met pursuant to adjournment.

Parties present as before.

In addition to the recitation of function contained in claim 2, indicating clearly that the "triple valve" of said claim is one competent to effect the direct admission of train-pipe air to the brake-cylinder, the fact, disclosed by the specification, that the invention of the patent consists in certain *additions* to the triple valve proper, by which certain functions are added, would naturally lead to the conclusion that the element designated in said claim as "a triple valve" was the triple valve proper of the patent when provided with the additional elements or members by which the further function of admitting train-pipe air directly to the brake-cylinder is performed.

The preliminary traverse of the piston mentioned in the claim I understand to be the movement, less than the full stroke, employed in making graduated or service stops; and the further traverse, to be the movement of the piston beyond the graduating position in making a full stroke—both of said motions being common to the ordinary triple valve proper, and neither being operative, in the triple valve proper, to effect the admission of air directly from the train-pipe to the brake-cylinder.

For the reasons stated above, I have concluded that the fifth element of the combination described in claim 2 is the new or
990 improved triple valve, composed of the old triple valve provided with the "additional members" by which it performs the further or added function of admitting air directly from the train-pipe to the brake-cylinder.

Claim 4 reads as follows:

"4. The combination, in a triple-valve device, of a case or chest, a piston fixed upon a stem and working in a chamber therein, a valve moving with the piston stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere, respectively, and an auxiliary valve actuated by the piston stem and controlling communication between passages leading to connections with a main air pipe and with the brake-cylinder, respectively, substantially as set forth."

I understand this claim to include the combination of certain enumerated elements which go to make up an improved form of triple valve, differing from the prior triple valves by the inclusion of an element or elements not found in said prior triple valves, and described in the patent as "an auxiliary valve," co-operating with

CARD 8

a passage or passages through which train-pipe air is conducted to the brake-cylinder. The enumerated elements are:

1. A case or chest for the reception and accommodation of the working parts and the various passages through which air is conducted.

2. A piston fixed upon a stem and working within a chamber or cylinder formed in the case.

3. A valve or valves moving with the piston stem and governing ports and passages leading to connections with an auxiliary reservoir and a brake-cylinder, for effecting the admission of auxiliary reservoir air to the brake-cylinder in applying the brakes, and between the brake-cylinder and atmosphere for exhausting the former in releasing the brakes.

4. An auxiliary valve arranged to be actuated by the
991 stem of the piston which controls the movement of the valve or valves for effecting the admission of auxiliary reservoir air to the brake-cylinder.

5. Passages in the case connecting with the train-pipe on the one side and the brake-cylinder on the other, said passages being controlled by the auxiliary valve.

The first three enumerated elements I understand belong to the triple valve proper, while the fourth and fifth elements constitute two of the three "additional members," by which the new or improved triple-valve device of the patent is distinguished from previous forms of the triple valve proper.

The auxiliary valve of this claim is, as I understand it, the "auxiliary slide-valve 41" of the specification, and the passages between which it exercises control are the passages leading up from the train-pipe to the port 42 on the one side, and from the port 42 to the brake-cylinder on the other.

I understand that the "auxiliary valve" is *auxiliary* or supplemental to the triple valve proper, and that its function is to open and close communication between the train-pipe and brake-cylinder, the movement of said auxiliary valve in opening communication between the train-pipe and brake-cylinder being effected, during the latter portion of the stroke of triple-valve piston, through a connection or contact with the latter.

I have not overlooked the fact that the combination of this claim is stated to be "in a triple-valve device;" but I understand this expression to be employed as descriptive of the new structure, including both a triple valve proper and the new or additional members.

In construing the foregoing claims, I have considered and regarded the auxiliary valve 41 of the patent as a material and essential element without which the several combinations recited would be inoperative to effect the desired results, and my reasons are briefly as follows:

First. Because but one embodiment of the alleged invention of the patent is shown or described therein;

992 *Second.* Because the auxiliary valve, the passage controlled thereby through which train-pipe air is conducted directly

into the brake-cylinder, and a check-valve located in said passage constitute the additional member or elements by which the alleged invention is distinguished from the prior art, and the triple-valve device of the patent is distinguished from the prior triple valve of the 1879 patent (220,556); and

Third. Because the auxiliary valve, as such, is specifically named in claims 1 and 4, and is necessarily implied in claim 2 for the reasons I have heretofore stated.

The answer is objected to as a purely legal opinion upon the scope of the claims enquired about and as therefore incompetent.

Recess.

Q. 10. Describe the construction and operation of the defendants' brake apparatus which is alleged by the complainants to be an infringement of said 1st, 2d, and 4th claims of patent No. 360,070.

A. As I understand the matter, the defendants' brake apparatus, which is alleged to infringe patent No. 360,070, is of two kinds, that is to say, includes the use of two forms of quick-action triple valve, the one represented in plate IX of defendants' 1889 catalogue, and the other represented in plate XI of defendants' 1891 catalogue, and Defendants' Exhibit Drawing of Triple Valve of Plate XI, Defendants' 1891 Catalogue. Each of the quick-action triple valves referred to is employed as part of an automatic air-brake system containing—

1. An air compressor or source of air supply, usually located upon the engine, and including an air pump and main air reservoir.

2. A train-pipe.

3. An engineers' valve for opening and closing communi-
993 cation between the main air reservoir and train-pipe, and between the latter and the atmosphere.

4. An auxiliary reservoir under each car.

5. A brake-cylinder under each car, and

6. The quick-action triple valve substituted for the ordinary triple valve.

The only substantial difference between the complainants' automatic air-brake equipment and that employed by the defendants is in the triple-valve mechanism.

I will first describe defendants' quick-action triple valve as exhibited in plate XI of defendants' 1889 catalogue, using the numerals and letters of reference appearing therein.

It consists of a valve casing 1, 2, provided with a piston chamber *c*, one end of which is in communication with the train-pipe through the coupling 22, the other end of said piston chamber communicating with the auxiliary reservoir through a prssage *b*. The valve piston 5 is provided with a hollow stem, the latter fitting a collar or thimble in the auxiliary reservoir end of the piston chamber. A valve chamber *d* is formed above the piston chamber, and said two chambers are in open communication through a small passage *e*, formed in the partition separating the valve chamber *d* from the piston chamber *c*. Above the valve chamber *d* is formed a chamber *g*, one end of which communicates with or opens into the brake-

cylinder, while the other end of said chamber *g* communicates through main port 16 with the upper end of the valve chamber. The check-valve 11 covers the upper end of the hollow piston stem and is held to its seat thereon by a spring 12. The upper end of the piston stem is provided with a piston valve 15, adapted to move in and out of the port 16 and thus open and close the passage through said port connecting the chamber *g* and the valve chamber *d*. In the upper end of the piston stem is formed a longitudinal passage, opening at one end into the valve chamber *d* and at the other into chamber *g*, and in said passage is arranged a
994 graduating valve 13, the lower end of said valve co-operating with a valve seat in the piston stem for opening and closing communication between the brake-cylinder and valve chamber, *d*, through the piston stem. Above the chamber *g* is arranged the release valve 18, said valve being provided with a stem 17 projecting downward and engaging the upper end of the graduating valve 13.

The release valve 18 is located in a chamber 20, which is in open communication with the brake-cylinder through the passage, *a*, and connects, through passages 19 controlled by release valve 18, with the passage, *f*, opening into the atmosphere. Although the drawing does not very satisfactorily disclose the fact, I understand that in the actual construction of the device, the passage *e*, connecting the piston chamber and the valve chamber is relatively smaller in cross-section than the passage *b*, connecting the auxiliary reservoir and the piston chamber, or, rather, two or more passages *e* are employed, the aggregate transverse area of said passages being less than the cross-section of passage *b*, and further, that the area of the graduating port controlled by graduating valve 13 is less than that of the passage or passages *e*. The passage through the valve stem controlled by the check-valve 11 is much larger than the passage or passages *e*.

Omitting from consideration the relative proportions of the several passages, and the separation of the valve chamber *d* from the auxiliary reservoir end of the piston chamber, and assuming that a free and full communication is provided between the auxiliary reservoir and valve chamber, so that the pressure of air in said valve chamber would at all times equal that in the auxiliary reservoir, the device as a whole would constitute an ordinary triple valve, possessing only the functions of a triple valve, such as that described in patent No. 220,556, that is to say: it would exhibit a feeding valve through which air from the train-pipe would be admitted to the auxiliary reservoir; an exhaust valve through which air from the brake-cylinder would be discharged
995 to the atmosphere; a main valve operating to fully uncover the passage between auxiliary reservoir and brake-cylinder, as in making an emergency or full stop; and a graduating valve through which air from the auxiliary reservoir would be admitted to the brake-cylinder intermittingly, in limited quantities, as in making graduated applications of the brakes. When thus operating as a triple valve proper to charge the auxiliary

reservoir, the maximum pressure of air in the train-pipe would be established, forcing the piston towards the auxiliary reservoir side, thereby inserting main valve 15 in the port 16, and causing the graduating valve to engage the stem 17 of release valve, and raise the latter, at the same time seating the graduating valve. As a result of this movement of the piston, the release port would be opened, and communication between the brake-cylinder and auxiliary reservoir through the graduating and main valves closed. The pressure of train-pipe air under check-valve 11 will unseat the latter and flow through the passages leading to the auxiliary reservoir, thus charging the latter.

The auxiliary reservoir having been charged, if the pressure in the train-pipe is reduced slightly, say from five to eight pounds, the piston will be moved, by the preponderating pressure of auxiliary reservoir air, to first seat the release valve 18, and then, by withdrawing the graduating valve 13 from contact with the release-valve stem 17 (which latter previously held the graduating valve to its seat), said graduating valve will be free to rise under the influence of auxiliary air, thus opening the graduating passage and permitting the air to flow into the brake-cylinder. During the performance of this operation the main valve 15 is not withdrawn from the port 16, and as soon as the pressure of auxiliary reservoir air is reduced, by expansion into the brake-cylinder, below the pressure of air in train-pipe, the piston will be moved towards the auxiliary reservoir end of the piston chamber until the graduating valve 13 engages the release-valve stem 17 and become seated, thereby arresting the flow of auxiliary reservoir air into the brake-cylinder. To increase
996 the pressure in the brake-cylinder, a further slight reduction of pressure in the train-pipe will be made as before. During this operation of graduating the release valve 18 remains seated.

To apply the brakes with full power in the shortest possible time, as in making an emergency stop, or in automatically applying the brakes, the pressure of air on the train-pipe side of the piston is suddenly or entirely reduced, and the piston under the influence of auxiliary reservoir pressure, will be caused to make its full stroke towards the train-pipe, thereby instantly withdrawing the piston valve 15 from the port 16 and opening a relatively large passage through which the air from auxiliary reservoir will flow to the brake-cylinder.

To release the brakes and recharge auxiliary reservoir, pressure in the train-pipe is restored, and the piston moved thereby to open release port, and close graduating and main valve ports, when the feeding will take place through the port controlled by the check-valve.

The operations described are generally the same as those performed by the "triple valve proper," and do not include the special function of a quick-action triple valve, as that term is used to indicate the depletion of the train-pipe and the delivery of the air from the train-pipe into the brake-cylinder.

The conversion of this triple valve proper, possessing the ordinary triple-valve functions, into a *quick-action* triple valve is most in-

geniously effected by the proper proportioning of the air ports or passages. By the interposition of the partition between the valve chamber *d*, and the piston chamber *c*, and the provision of a passage or passages *e*, less in cross-section then the passage *b*, communicating between auxiliary reservoir and piston chamber, it becomes possible to produce or occasion *differential pressures* in the piston chamber and the valve chamber, that is to say, the air in the piston chamber being at all times maintained at auxiliary reservoir pressure, and the air being compelled to traverse the restricted
997 passage *e*, before it enters the valve chamber, if the pressure
in the latter is suddenly lowered to a considerable degree, as by expanding the air suddenly into the brake-cylinder, the quantity of air admitted through the restricted passage *e*, will be insufficient to at once raise the pressure in the valve chamber, *d*, to that in the auxiliary reservoir, and there will be a momentary but decided difference in the pressures, notwithstanding the fact that the discharge of air through passage *e* commences at once and is continuous until an equalization of pressure is produced.

Normally the pressure in the valve chamber *d* and the auxiliary reservoir end of piston chamber *c* are equal; but when the train-pipe pressure is suddenly reduced, say 15 to 20 pounds, and the piston is operated to withdraw the main valve 15 from its port or passage 16, thus permitting a full and free flow of air from the valve chamber *d* to the brake-cylinder, the pressure in valve chamber *d* will be instantly reduced (the flow of auxiliary reservoir air through the passage or passages *e* being retarded), and, falling below the retained pressure in train-pipe, the air from the latter will immediately unseat the check-valve 11, and, mingling with that issuing through the restricted passage or passages *e*, will flow through the port controlled by the main valve 15 and enter the brake-cylinder. The flow of air from the train-pipe continues until the pressure in the valve chamber *d* nearly equals that in the train-pipe, when the check-valve will close and the air from the auxiliary reservoir will continue to be discharged through the passage *e*, and main valve port 16 into the brake-cylinder.

The discharge of air into the brake-cylinder through the graduating valve, in making graduating applications of the brakes, does not effect an unseating of the check-valve and the admission of train-pipe air, because the capacity of the graduating valve to permit the passage of air is less than that of the opening or openings *e*, through which auxiliary reservoir air flows into the valve chamber, hence the pressure in valve chamber *d*, will remain the same
998 as in the auxiliary reservoir and the auxiliary reservoir end
of piston chamber. As the movement of the piston, to effect the opening of the graduating port, is due to the preponderance of auxiliary reservoir air pressure and the same preponderance of pressure is being exerted in the valve chamber *d*, it follows that the check-valve will be held to its seat and the ingress of train-pipe air prevented. It is only when the conditions are such that the pressure existing in the valve chamber *d*, *momentarily falls* below the pressure of air in the train-pipe, that air from the train-pipe can

raise the check-valve and enter the valve chamber, and this condition is established when the main valve 15 is quickly withdrawn from its port and a relatively large escape port opened, through which the air in valve chamber *d*, can expand rapidly into the brake-cylinder.

5 p. m., adjourned to meet at same place on Thursday, May 18th, at 10.30 o'clock a. m.

10 30 A. M., MAY 18TH, 1893.

Met pursuant to adjournment.

Parties present as before.

I will now explain the second form of defendants' quick-action triple valve (illustrated in the 1891 catalogue) by reference to "Defendants' Exhibit Drawing of Triple Valve of Plate XI, Defendants' 1891 Catalogue," and "Defendants' Exhibit Section of Defendants' Triple Valve, Plate XI, 1891, Catalogue."

This triple valve involves the same principle of operation as the 1889 triple valve, before described; and its quick-action function is due to the same ingenious proportioning of the ports and passages, and the interposition of a partition separating the auxiliary end of the piston chamber from the valve chamber, whereby the triple valve proper is rendered capable, under certain conditions, of effecting the admission of train-pipe air into the brake-cylinder, in conjunction with auxiliary reservoir air, to apply the brakes
999 with full power; the withdrawal of air from the train-pipe serving to deplete the latter, and at the same time augment the pressure in the brake-cylinder.

The ports and passages in the valve case are substantially the same, as are also the piston and the check-valve, but the form of the release valve, the graduating valve and the main valve, together with the ports controlled thereby, is changed, without, however, substantially changing or modifying the functions of these parts. In the exhibit drawing to which I have referred, the passage leading from auxiliary reservoir to piston chamber is marked A; the piston chamber D; the piston 29; the feed-passage through stem of piston F; the check-valve 26 controlling the feed-passage F; the valve chamber C; the partition 9 between valve chamber and piston chamber; the restricted passage B connecting valve chamber and piston chamber; the chamber or passage H leading from the main valve to the brake-cylinder; the exhaust passage G; the train-pipe connection 1; and the main valve port or passage through bushing 10 connecting the valve chamber and the chamber H leading to brake-cylinder.

The piston valve, 15, of the 1889 triple valve is replaced by a poppet valve 22 through which the stem 18 of the piston 29 passes, said stem being provided with shoulders for engaging the main valve, to move the latter, and at the same time permit a limited movement of the piston independently of the main valve. The graduating valve is formed by a port 40, in valve stem 18; said port communicating with a small passage in the valve stem opening into chamber H. The port 40 alternately enters and is with-

drawn from the main valve 22, accordingly as the piston is moved toward the auxiliary reservoir side or the train-pipe side, and when said port 40 is carried within the main valve 22, the graduating passage is closed and when the port is withdrawn from within the main valve 22, as the piston moves towards the train-pipe side, communication is established between the valve chamber C
1000 and the brake-cylinder, through the passage in the valve
stem and the chamber H.

The poppet valve 18 which controls the escape of air from the brake-cylinder to the atmosphere in the 1889 triple valve, is here replaced by a piston valve 17 attached to the end of the valve stem 18, and, working in a port or passage I, the latter connecting chamber H and the brake-cylinder with the exhaust passage G.

A spring 16 whose range of motion is limited, engages or is engaged by the end of piston stem 18.

In describing the operation I will first explain the movements of the several parts in effecting graduating applications of the brakes. The maximum or working pressure being established in the train-pipe, the piston 29 is forced towards the auxiliary reservoir end of its chamber until it arrives at the position represented in the drawing, whereupon main valve 22 is seated, and graduating valve port 40 is carried within said main valve, thereby closing communication between the valve chamber and the brake-cylinder; at the same time, the release valve 17 is moved from port I, compressing the spring 16, and opening communication from the brake-cylinder to the atmosphere through the chamber H, port I, and passage G. The check-valve 26 is raised from its seat by the pressure of train-pipe air, and the latter flows into valve chamber C, from whence it is conducted to the auxiliary reservoir, through the restricted passage B, piston chamber D and large passage A. As soon as the pressure is equalized, or nearly so, in auxiliary reservoir and train-pipe, check-valve 26 is seated by its spring, and the return of air to the train-pipe is prevented. If, now, the pressure in train-pipe is slightly reduced, so as to create a slight preponderance of pressure on the auxiliary reservoir side of the piston, the latter will be moved towards the train-pipe side, first closing the escape from the brake-cylinder, by causing the piston valve 17 to enter the port I, and next opening communication between the valve chamber C and the brake-cylinder, by the withdrawal of graduating port 40 from within the main valve 22, the latter being held
1001 to its seat by the pressure of air in valve chamber C. Under
the conditions named, the piston continues its motion towards the train-pipe side until the shoulder on piston stem 18 engages main valve 22; and the reduction of pressure in train-pipe not being sufficient to overcome the resistance offered by main valve 22, the further movement of the piston is arrested and it remains stationary until the pressure on auxiliary reservoir side is so far diminished, by the escape of air through the graduating port and passage into the brake-cylinder, that the retained train-pipe pressure will gradually preponderate and move the piston towards the auxiliary reservoir, thereby carrying the graduating port 40 within the main

valve 22, and arresting the further flow of auxiliary reservoir air to the brake-cylinder, without, however, opening the release port 1. Owing to the fact that the graduating port is smaller and, hence, has a less capacity for the discharge of air than the passage B through which auxiliary reservoir air enters the valve chamber C, the pressure in said chamber C will remain the same as that in auxiliary reservoir, and the check-valve 26 will remain seated. To effect a further increase of pressure in the brake-cylinder, by graduation, the pressure in the train-pipe is again diminished slightly, and the operations described are repeated.

To release the brake and recharge the auxiliary reservoir, the pressure in train-pipe is restored, and the piston forced to the auxiliary reservoir end of the chamber, thereby opening the exhaust passage from the brake-cylinder, and also permitting air to enter through the check-valve port.

To make what is termed a "quick-action" or "emergency" application of the brakes, the pressure in the train-pipe is quickly and considerably reduced, say to the extent of 15 to 20 pounds. The auxiliary reservoir air being now under a pressure of from 15 to 20 pounds greater than that in the train-pipe, it instantly compels the piston to make a full stroke towards the train-pipe, unseating the main valve 22 so that the air in valve chamber C imme-
1002 diately rushes through the large port in bushing 10 into the brake-cylinder. The auxiliary reservoir air is retarded by the restricted passage B, and, notwithstanding the fact that it is under a much higher pressure than the train-pipe air, it cannot at once restore the pressure in valve chamber C; and the pressure of train-pipe air, being for the moment greater than the pressure in valve chamber C, raises the check valve 26 from its seat and train-pipe air flows through the feed-opening F into the valve chamber, where it joins the auxiliary reservoir air entering through the passage B and is conducted through the main valve port in bushing 10 into the brake-cylinder. The flow of train-pipe air through the feed-opening F ceases the moment the pressure in valve chamber C nearly equals that in the train-pipe, but this does not occur until a considerable volume of train-pipe air has passed through the large feed-passage F and large main valve port in bushing 10 into the brake-cylinder, where it serves to increase the braking power above that which would be exerted by the auxiliary reservoir air alone; and at the same time, by the withdrawal or escape of air from the train-pipe, the action of the brake mechanism on succeeding cars is quickened.

It will thus be seen that the quick-action principle involved in this structure rests entirely upon the establishment of *momentary differential pressures* on the auxiliary reservoir and train-pipe sides of the piston, and in the valve chamber C, into which latter both train-pipe air and auxiliary reservoir air are discharged at the same time, and from which they are conducted through the *same* main valve port to the brake-cylinders; and, further, that the pressures on train-pipe and auxiliary reservoir sides of the piston and in the valve chamber C being normally equal, (which is the condition

when the brakes are released and the train-pipe charged with air at maximum pressure) the differential conditions will then be established when the train-pipe pressure is suddenly and considerably lowered, the air in valve chamber C quickly discharged and the flow of auxiliary air into the valve chamber C retarded.

1003 Recess.

In describing the defendants' quick-action triple valve of the 1889 and 1891 catalogues, I have referred to the mechanism, (exclusive of the partition separating the valve chamber from the auxiliary reservoir end of the piston chamber in which the restricted passage *e* [or B] is formed,) as a triple valve proper, meaning thereby a valve mechanism having a connection with the train-pipe, another with the auxiliary reservoir, a third with the brake-cylinder and a fourth with the atmosphere; with valves controlling the feed-passage between train-pipe and auxiliary reservoir, between the brake-cylinder and atmosphere and between the auxiliary reservoir and brake cylinder—and my reasons for thus classifying defendants' triple valves are as follows:

The triple valve, as it was known prior to the year 1879, did not contain a separate "graduating valve," but relied upon the partial or intermittent opening of the main valve port for effecting graduating applications of the brake, by the admission of less than the full pressure of auxiliary air into the brake-cylinder; and provision was made whereby the main valve port would be widely opened or wholly uncovered for admitting auxiliary reservoir air directly into the brake-cylinder, to apply the brakes with full force and in the quickest possible time. Generally speaking, the means by which these operations and the operations of feeding the auxiliary reservoir and exhausting the brake-cylinder were performed was by a combination of parts corresponding substantially with the defendants' triple valve, omitting the "partition" and the graduating valve; the omission of the partition separating the valve chamber from the piston chamber and the restricted supply passage *e* (or B) being accompanied by the production and maintenance of full auxiliary reservoir pressure in the valve chamber. The forms of the
1004 valves employed varied greatly, as did their arrangement, but the general combination and mode of operation was the same as the defendants' valve mechanism.

As illustrating the prior art I will refer to the patents of Westinghouse, No. 141,685, of August 12, 1873, and No. 144,006, of October 28, 1873; Perkins, No. 163,242, of May 11, 1875; Jones, No. 166,386, of August 3, 1875; Perrine, No. 166,405, of August 3, 1875, and Westinghouse No. 172,064, of January 11, 1876. In each of the patents referred to is shown a triple valve containing the following elements—form disregarded—found in defendants' triple valves.

A valve casing; a piston chamber D (or *c*); a piston 29 (or 5), subjected on one side to auxiliary reservoir pressure and on the other to train-pipe pressure; a feeding-in valve 26 (or 11), through which train-pipe air is admitted to the auxiliary reservoir in charging the latter; a release valve 17 (or 18) for opening and closing

the exhaust from the brake-cylinder, and a main valve 22 (or 15), actuated by the piston and controlling a port or passage leading from the auxiliary reservoir into the brake-cylinder.

In some of these prior structures a main valve similar to the piston valve 15 of the 1889 catalogue was employed for controlling the flow of auxiliary reservoir air to the brake-cylinder, as illustrated, for example, in the Perkins patent No. 163,242, the Jones patent No. 166,386 and the Perrine patent No. 166,405; while in others the poppet form of main valve 22, shown in defendants' 1891 catalogue, was used, as illustrated, for example, in the Westinghouse patents Nos. 141,685 and 144,006. It was also common to employ a check-valve for the feeding-in valve, similar to the check-valve 26 (or 11), said check-valve being carried by the piston, as in defendants' valves; this feature is shown in the Westinghouse patent No. 144,006; Perkins No. 163,282, Jones No. 166,386 and Boyden No. 280,285.

In 1879 the graduating valve, as a separate feature of the triple valve, that is to say, performing a part of the functions of the main valve in effecting graduating applications of the brake, was
1005 introduced and became a part of the device known as a
"triple valve," and by a comparison of defendants' triple valves with patent No. 220,556 of 1879, I find the functional equivalent of the graduating valve 40 (or 13) in the graduating valve *e'* of said patent.

Referring to said patent No. 220,556 of 1879, and comparing the same with defendants' triple valves, I find that they all possess substantially the same functions, are made up of equivalent parts that operate in substantially the same manner, omitting, of course, the quick-action function of defendants' valve and the means by which such action is produced. The piston G, working in piston chamber B of the patent, and subjected to auxiliary reservoir air on one side and train-pipe air on the other, is represented in defendants' triple valves by the piston 29 (or 5) and piston chamber D (or *c*); the feeding-in valve of the patent, represented by the port *a*, and the end of the graduating stem *b'* in figure 1, and by the piston and groove, *a*, in figure 4, corresponds generally with the feeding-in passage and check-valve 26 (or 11); the release valve, *s*, of the patent, through which air from the brake-cylinder is discharged into the atmosphere, corresponds functionally with the release valve 17 (or 18); the main valve H of the patent controlling the direct passage between valve chamber and brake-cylinder, and only operated to uncover the port leading to the brake-cylinder when the piston is actuated by the preponderance of auxiliary reservoir air pressure, and caused to make its full stroke, finds its functional equivalent in the main valve 22 (or 15) of defendants' triple valves; and the graduating valve *e'* of the patent, and the graduating passage controlled thereby, are functionally represented by the stem 18, with its graduating port 40, and graduating passage in defendants' 1891 triple valve and by the graduating valve 13, with its port and passage of defendants' 1889 triple valve.

Upon comparing the operations performed by the triple valve of

said patent No. 220,556, with the operations performed by
1006 defendants' valves, and omitting the quick-action of the latter,
I find them to be substantially identical, that is to say, upon maximum pressure being established in train-pipe, the pistons will be forced towards the auxiliary reservoir ends of their respective piston chambers and train-pipe air will be admitted through the feeding-in valves to charge the respective auxiliary reservoirs. Each piston moves its release valve to uncover the escape or exhaust port from the brake-cylinder during the last portion of the stroke when moving to the feeding-in position. To apply the brakes with less than the maximum power of auxiliary reservoir air, as in making graduated or service stops, a slight reduction of pressure in the train-pipe will cause each piston to perform a partial stroke toward the train-pipe, first closing the release port and then opening the graduating passage, when auxiliary reservoir air will flow into the brake-cylinder until the pressure on auxiliary reservoir side of piston is so far reduced that the train-pipe air will operate to move the piston and close the graduating port, but without opening the exhaust. In the patented device a preliminary movement of the main valve is involved in performing the graduating operation, and the same is true of defendants' 1889 valve; but in defendants' 1891 valve no movement of the main valve is required for this operation, the stem 18, in which the graduating port is formed, moving freely through the main valve 22; moreover, in the patent, the graduating stem *b′* serves to limit the movement of the piston in graduating, and a similar office is performed by the main valve 22 of defendants' 1891 valve. When the pressure in train-pipe is suddenly reduced to a considerable degree, or entirely, the piston of each of the triple valves referred to will be caused to make its full stroke toward the train-pipe, and, in so doing, it will first close the release valve and then withdraw or remove the main valve from the port or passage leading from the valve chamber to the brake-cylinder, so that auxiliary reservoir air will flow directly into
the brake-cylinder without being compelled to pass through
1007 the smaller graduating passages. During this movement of
the piston and main valve a slight but inefficient discharge of air will take place through the graduating passages, as said passages are opened before the main valve uncovers its port.

Such would be the function and operation of the defendants' triple valve in the absence of the "partition" separating the valve chamber from the auxiliary reservoir end of the piston, and the restriction placed upon the flow of auxiliary reservoir air through said valve chamber; and the addition of those elements which contribute in establishing the momentary differential pressures in valve chamber, auxiliary reservoir and train-pipe, do not in any way change or modify the action of the triple-valve members, but merely effect the addition of train-pipe air to the auxiliary reservoir air, which latter would otherwise alone be delivered to the brake-cylinder when an emergency application of the brakes was attempted.

4.55 p. m.—Adjourned to meet at same place on Friday, May 19th, 1893, at 10.30 o'clock a. m.

10.30 A. M., MAY 19TH, 1893.

Met pursuant to adjournment.
Parties present as before.

A comparison of the mechanism of defendants' triple valve with the triple valve of patent 141,685 of August 12th, 1873, will serve to illustrate the fact that the main valve 22 of the 1891 triple valve (which operates to perform the same functions of admitting auxiliary reservoir air to the brake-cylinder upon the full stroke of the piston, and is the equivalent of main valve 15 in the 1889 triple valve) is the main valve, and corresponds in its functions with the main valve *a*, of the patent referred to. The patent shows a piston the equivalent in operation of piston 29 or 5; a feed-valve through which air is conducted to the auxiliary reservoir through the
1008 valve chamber, said feed-valve being specifically different in construction but generically an equivalent of the check-valve 26 or 11; a release valve *h'*, operated by a stem *s'*, passing through the main valve and attached to the piston, similarly to the stem 18 of defendants' 1891 valve, and serving to engage the spring-pressed release valve *h'*, the latter being of the same type and having the same mode of operation as the release valve 18 of defendants' 1889 triple valve (the equivalent of the release valve 17 in defendants' 1891 triple valve;) and a main valve *a*, of the poppet form engaging a large supply port, through which communication is established between the auxiliary reservoir and valve chamber on the one side, and the brake-cylinder on the other, just as does the main valve 22 of defendants' 1891 triple valve, said main valve of the patent being so connected to the piston that the latter may have an independent motion, to close the release valve at the beginning of the stroke of piston towards train-pipe side, and to engage and move said main valve to uncover its port during the latter portion of the stroke of said piston after the release valve has been closed; just as in defendants' 1891 triple valve. The piston and its attached stem 18 are retracted to close the release-valve port before the shoulder on the stem engages the main valve 22, to remove the latter from its port. The specific difference between the triple valve of patent No. 141,685 and defendants' 1891 valve lies in the introduction of a separate graduating valve, represented by the graduating port 40 and graduating passage in stem 18 of defendants' 1891 triple valve, to perform a part of the functions of the main valve, as described in the patent No. 220,556 of 1879. I find in patent No. 141,685 that a tapered plug *o*, was applied to the under side of the main valve *a*, for use in effecting graduating application of the brakes, said tapered plug entering the main valve port *o'* and operating to diminish the capacity of said main valve port, when the main valve was only partially unseated, and thereby diminish the amount of compressed air passing through said main valve port while
1009 graduating. In defendants' triple valve the flow of air while graduating is controlled by the graduating valve, but in effecting full application of the brakes without graduating, the main valves of both the patented and defendants' triple valve are employed

Since 1879 the graduating valve has been generally recognized as a part of the triple valve proper, and in incorporating this feature in their triple-valve structure the defendants have, in effect, removed the graduating plug of patent No. 141,685, and utilized the part corresponding to stem *s'* to perform the graduating functions, by providing said stem with a graduating port and passage.

In this comparison I have merely attempted to show that in the general features of construction the defendants' triple-valve mechanism corresponds generally though not specifically, with the device or mechanism known as the triple valve *prior* to the advent of what is now termed the "quick-action triple valve," and it is only since the latter event that a change has been made in the use of the term "triple valve" as designating a valve mechanism containing a feeding valve, a release valve, and a main and graduating valve controlling the flow of air from the auxiliary reservoir to the brake-cylinder in making graduated or service stops and emergency stops. In proof of the fact that a new name has been given to what was generally recognized as *the* triple valve of the Westinghouse system, constructed in accordance with the invention of patent No. 220,556 of 1879, I quote the following passage from page 19 of a book entitled "The Westinghouse Air-brake Company, Pittsburg, Pa., U. S. A., Instruction Book," bearing the imprint 1890.

(The right of exception to the book named is reserved by counsel for complainant; it not appearing that the book is in evidence, or that it is published under the authority of the complainant, or is an authoritative explanation of the complainants' apparatus.)

1010 "The plain automatic triple valve."

"A perspective view of the plain automatic triple valve and locomotive-tender brake apparatus, is shown in plate 1, Fig. 3, and cross-sections of the triple valve in Figs. 4 and 4*a*, which will clearly show its construction. It is desirable that this triple valve be perpetuated for the use with locomotive driving wheels and tender brakes, to give a slightly slower action of the brakes thereon in cases of emergency action to the quick-action apparatus on cars.

"The construction and operation of the plain automatic triple valve is substantially the same as that of the quick-action form, the quick-action valves being omitted, and pressure used only from the auxiliary reservoir in applying the brakes, and will not, therefore, require specific description."

I have examined the drawings referred to in the passages quoted, and find they illustrate the triple valve of patent No. 220,556, and it will be observed that it is here referred to as the "*plain* automatic triple valve" to distinguish it from the new valve called the "quick-action triple valve." The quick-action triple valve referred to in the instruction book is not of the form shown and described in patent No. 360,070, although possessing the functions of admitting air from the train-pipe directly into the brake-cylinder when effecting an emergency application of the brakes.

Q. 11. State whether or not you find defendants' quick-action air-brake apparatus, in either of its forms, to be an infringement of all or any of the claims numbered 1, 2, and 4, of complainants' patent No. 360,070, giving your reasons with your opinions.

(Objected to by counsel for complainants as calling for an opinion in law, and as incompetent.)

A. I am clearly of the opinion that the defendants' quick-action air-brake apparatus does not infringe either of the claims re-
1011 ferred to in the question, and that in neither form of apparatus employed by defendant- is embodied or used the combinations of devices, or their known equivalents, specified and described in the first, second and fourth claims of patent No. 360,070, and my reasons are as follows:

I will first explain what I understand to be the radical differences in structure and mode of operation between the invention of patent No. 360,070 and the apparatus as constructed and used by the defendant, and will then proceed to point out wherein the defendants' apparatus differs from the inventions recited in the claims mentioned.

According to the invention of the patent certain 'additional members," of which the auxiliary valve 41 and an independent passage around the triple valve proper are essential elements, were added to the ordinary triple-valve mechanism, forming part of the ordinary automatic air-brake system, for effecting the direct admission of train-pipe air to the brake-cylinder when the triple valve was operated for effecting a quick application of the brake, as in making an emergency stop. The admission of train-pipe air to the brake-cylinder is effected by the movement of the auxiliary valve in opening the passage around the triple valve proper, and is in nowise affected by the valves of the triple valve proper these parts performing their usual functions.

Recess.

Now, the usual functions of the triple valve proper were three-fold, to wit: 1st, controlling the admission of train-pipe air to the auxiliary reservoir, for charging the latter, and preventing a return of the air to the train-pipe when the pressure in the latter was reduced; 2nd, controlling the escape of air from the brake-cylinder, by opening communication with the atmosphere when releasing the brakes, and closing the escape passage when applying the brakes; and 3rd, controlling the admission of air from the auxiliary reservoir into the brake-cylinder, said control being effected in
1012 two ways and for two different kinds of applications of the brake, (*a*) controlling the admission of air to the brake-cylinder through the graduating passage and by the graduating valve, and (*b*) controlling the direct admission of air to the brake-cylinder by the action of the main valve uncovering a port opening directly into the valve chamber and holding said port open until the pressure equalized in the brake-cylinder. As the additional members of the patent 360,070 were not to effect the graduating

function, but were only to be called into action in making a full application of the brakes, the auxiliary valve was arranged in such a manner that it would be moved, to uncover passage leading directly to the brake-cylinder, slightly in advance of the action of the triple valve proper in opening the line of communication between auxiliary reservoir and brake-cylinder, as in making emergency stops; hence the auxiliary valve was arranged to be moved by the piston of the triple valve proper during the latter portion or that part of the stroke of the piston which ordinarily effected an emergency application of the brakes by opening direct communication between auxiliary reservoir and brake-cylinder, and permitting equalization of pressure in auxiliary reservoir and brake-cylinder.

It will be observed that the additional members of the patent (by which I mean the auxiliary slide-valve, the passage and the check-valve) have nothing whatever to do with the operation of the triple valve proper, and, while for convenience they were located in the casing of the triple valve proper, they might, so far as the functional performance is concerned, be made separate from the triple valve, the only necessary connection being one by which the motion of the piston would be communicated to the auxiliary valve at the proper time. Thus the triple valve proper performed *its* functions, and the additional members performed *their* functions with the result that when an emergency application of the brake was required, the triple valve proper was operated to discharge auxiliary reservoir air continuously into the brake-cylinder, and the "additional
1013 members" were operated to open another line of communication, to wit: that between train-pipe and brake-cylinder, through which train-pipe air under a lower pressure than auxiliary reservoir air would be admitted to the brake cylinder.

I am unable to find in the patent any hint or suggestion of a means or mode of operation, other than those of the "additional members," whereby the admission of train-pipe air directly into the brake-cylinder is or can be effected by the triple-valve mechanism, and without the use of a valve auxiliary to the triple valve; and the specification of the patent contains a direct implication that a triple valve proper, possessing all the functions of such a valve, is incapable of effecting the direct admission of train-pipe air into the brake-cylinder.

Turning now to the quick-action triple valves as made and used by the defendants, it appears that the results effected by the additional members of the patented device are produced in defendants' valves directly by the triple valve proper and without the addition of an extra passage or an auxiliary valve; and that the only substantial change which is required to convert a triple valve proper into what is now known as a "quick-action triple valve" is the separation of the valve chamber from the auxiliary reservoir end of the piston chamber, and the introduction of the small passage *e* (or B) through which auxiliary reservoir air is compelled to pass in entering the valve chamber. *With these changes* and the use of a check-valve for the feeding-in valve (a use which was common in the art as exhibited in numerous prior patents, as, for example,

patents Nos. 144,006 of October 28, 1873; 166,386 of August 3, 1875, and 280,285 of June 26, 1883.) *Mr. Boyden has succeeded in making a triple valve perform the operation of admitting train-pipe air directly into the brake-cylinder* without interfering with its functions as a triple valve proper, and without the addition of anything corresponding in name, construction or mode of operation with the
1014 auxiliary valve and its passage connecting the train-pipe and brake-cylinder, which auxiliary valve and passage constitute two of the three additional members of the patent 360,070, and are absolutely essential to the operation of the device described in the patent, when used to effect a discharge of train-pipe air directly into the brake-cylinder.

In the complainants' patented structure, *two valves are required* for effecting an emergency application of the brakes, one of said valves being the main valve of the triple valve proper by which communication is established between the auxiliary reservoir and brake-cylinder, and the other, the auxiliary valve by which communication is established between the train-pipe and brake-cylinder independently of the triple valve proper.

In the defendants' structures, *a single valve*, to wit: the main valve 15 (or 22) co-operating with a single valve port, serves to admit both auxiliary reservoir air and train-pipe air to the brake-cylinder, no additional or auxiliary valve being employed.

In the patented device, six valves or valve functions are necessary to the performance of all the functions pertaining to the triple valve proper and to the "additional members," to wit: (1) a feeding-in valve; (2) an escape or release valve; (3) a graduating valve; (4) a main valve; (5) an auxiliary valve, and (6) check-valve. The first four of the six valves mentioned relate to the triple valve proper, and the fifth and sixth to the additional members by which train-pipe air is admitted to the brake-cylinder.

The defendants' quick-action triple valves contain only the first four valves, to wit: (1) a feeding-in valve; (2) an escape or release valve; (3) a graduating valve, and (4) a main valve, omitting entirely the fifth and sixth valves, to wit: the auxiliary valve, and the check-valve located in the passage governed by the auxiliary valve and leading from the train-pipe to brake-cylinder.

In making this comparison between the number of valves,
1015 I have considered the graduating valve and the port at the end of the graduating passage, in the structure shown in the patent, as a single valve, although there are, in fact, two valves employed in making the graduated admission of air from auxiliary reservoir to the brake cylinder; whereas, in the defendants' structure, a single graduating valve is employed in each instance.

In the patented device it is requisite and necessary that the auxiliary valve should be moved by the piston to uncover a port for the admission of train-pipe air to the brake-cylinder; whereas in defendants' structures there are no auxiliary valves, nor is train-pipe air admitted through a passage distinct from the triple valve proper; but, on the contrary, the admission of train-pipe air to the brake-

cylinder is effected by the establishment of *momentary differential pressures* in the valve chamber and on opposite sides of the piston, which is rendered possible by the interposition of the partition separating the valve chamber from the auxiliary reservoir end of the piston chamber, and restricting the flow of auxiliary reservoir air into said valve chamber, thereby establishing conditions favorable to the entrance of train-pipe air, under less pressure than auxiliary reservoir air, into the valve chamber, where it joins the auxiliary reservoir air, and they pass together through the main valve port of the *the* triple valve proper into the brake-cylinder.

In the patented structure the auxiliary valve is distinct from the triple valve proper and its piston, and is acted upon by the latter during the latter part of its stroke, and while carrying the main valve to open communication between the train-pipe and brake-cylinder; whereas, in the defendants' structures, there is no auxiliary valve, no passage opened by an auxiliary valve, and the admission of train-pipe air to the brake-cylinder is not effected by the opening of any valve alone, nor the opening of any passage alone, as in the patented structure, but is effected by the opening of the main
1016 valve port when the structure and conditions are such that
the momentary differential pressures in valve chamber and piston chamber will be produced.

4.50 o'clock p. m.—Adjourned to meet at same place on Saturday, May 20th, 1893, at 10.30 o'clock a. m.

10.30 A. M., MAY 20TH, 1893.

Met pursuant to adjournment.
Parties present as before.

In the patented device, during the *automatic* applications of the brakes, resulting from the depletion of the train-pipe, the auxiliary valve will open its port, but no appreciable amount of train-pipe air will enter the brake-cylinder, the application of the brakes being effected by the auxiliary reservoir air passing through the triple valve; and in the absence of the check-valve 49 the auxiliary reservoir air, instead of entering the brake-cylinder, would be discharged through the independent passage controlled by the auxiliary valve and escape into the train-pipe; hence the devices of the patent would be inoperative for effecting that most desirable operation of automatically applying the brakes, if the check-valve 49 were omitted.

In the defendants' triple valves the *automatic* action would take place precisely the same as with the ordinary or plain triple valve, due to the fact that the main valve controls the entrance of both train-pipe air and auxiliary air to the brake-cylinder, and the admission of train-pipe air is effected through the feeding-in valve; hence, the same conditions which effect the closing of the feeding-in port in the automatic application of the brake, prevent the return of air to the train-pipe when the pressure in the latter is entirely relieved, thereby rendering possible and practicable the utilization of auxiliary reservoir air in the brake-cylinder without the employ-

ment of a separate check-valve for preventing the discharge of auxiliary reservoir air into the train-pipe.

1017 Turning now to the claims, I do not find in defendants' quick-action air-brake apparatus, in either of the forms referred to in the question, the combination of devices specified in claim 1; for the reason that defendants' said apparatus does not contain the sixth element included in said claim, to wit: "An auxiliary valve device actuated by the piston of the triple valve and independent of the main valve thereof, for admitting air in the application of the brake directly from the main air pipe to the brake-cylinder, substantially as set forth," nor any device the equivalent of that described and referred to, operating in substantially the same manner.

The combination of the claim includes the brake-equipment of a single car, and differs from the ordinary automatic air-brake equipment made up of the first five enumerated elements only in the addition of the "auxiliary valve device," the latter being *independent* of the "main valve" of the triple valve proper, and so arranged that it will be actuated by the piston of the triple valve proper to open a passage between the train-pipe and brake-cylinder and admit air directly from the former to the latter. The air thus admitted by the "auxiliary valve device" is additional to the auxiliary reservoir air admitted to the brake-cylinder by the triple valve proper.

The defendants' apparatus contains the first five elements of the claim; that is to say, it has a train-pipe, means for maintaining and varying the air pressure in said train-pipe, an auxiliary reservoir, a brake-cylinder and a triple valve; but it omits the "auxiliary valve device" entirely, hence it has no such device independent of the main valve of the triple valve, nor one which is actuated by the piston of the triple valve. The results produced by all of said apparatuses are substantially the same; that is to say, each effects the admission of train-pipe air to the brake-cylinder, in conjunction with auxiliary reservoir air, when operated to effect an emergency application of the brake by a sudden and considerable reduction of pressure in the train-pipe; but in
1018 the patented device this result can only be effected by the "auxiliary valve device" of the claim acting in conjunction with the triple valve proper; whereas in defendants' apparatuses the result is effected by means of the triple valve alone, *when provided* with a partition separating the valve chamber from the piston chamber, and a restricted passage between auxiliary reservoir and valve chamber. In the one case (complainants' patent 360,070) the admission of train-pipe air is controlled by the movement of *an auxiliary valve* to open a passage independent of the triple valve proper; in the other (defendants' valve device) train-pipe air is conducted through and controlled by the *main valve of the triple valve*, and its admission is induced by the establishment of momentary differential pressures within the triple valve.

The second claim of the patent, I understand, includes a combination of five elements, of which the fifth, to wit, the "triple

valve," is not the same triple valve included under that designation in claim 1, but in the *new* triple valve composed of a triple valve proper, together with the "*additional members*" by which it is made to perform the further function of admitting air directly from the train-pipe to the brake-cylinder during that portion of the stroke performed by the piston of the triple valve proper in opening a passage between auxiliary reservoir and brake-cylinder for the continuous discharge of air into the latter.

The two forms of apparatus made by defendants contain four of the five elements of this claim, but they do not, in my opinion, make use of the fifth element, nor its equivalent, in its construction or mode of operation. The defendants' triple valves are not provided or combined with the "additional members" of the patent, to wit, an auxiliary valve, the passage connecting the train-pipe and brake-cylinder controlled by said valve and a check-valve governing the flow of air through said passage in one direction; nor are they provided with "additional members" the equivalent in construction and mode of operation of those of the patent; on
1019 the contrary, the triple valves made by defendants differ generally from the ordinary triple valves only in two particulars, to wit: The *partition* separating the valve chamber from the piston chamber and the *restricted passage* through which auxiliary reservoir air is conducted into the valve chamber, neither of which elements corresponds in function or mode of operation with the three "additional members," or either of them, which form part of the new triple valve constituting the fifth element in claim 2 of the patent.

It is true that the results produced by the patented triple valve and by defendants' triple valves are substantially the same; that is to say, in each air is admitted from the auxiliary reservoir to the brake-cylinder during the first portion of the traverse of the triple-valve piston, as in making graduated applications of the brake, and air from both the auxiliary reservoir and the train-pipe are admitted to the brake-cylinder during the further or final traverse of the triple-valve piston; but the means employed, and which I understand is all that the claim covers, are not the same nor equivalents. The triple valve of claim 2 operates as an ordinary triple valve and performs the two functions of effecting the admission of auxiliary reservoir air to the brake-cylinder during both the preliminary and final or complete movement of its piston, while the further function of admitting train-pipe air to the brake-cylinder is performed by the auxiliary valve and passage of the "additional members." In each of defendants' triple valves air is admitted to the brake-cylinder from the auxiliary reservoir during the preliminary movement or traverse of the piston, and air from both the auxiliary reservoir and train-pipe is simultaneously admitted to the brake-cylinder, *through* the triple valve and *by* the main valve thereof.

It is true defendants' triple valves are provided or formed with certain parts not found in ordinary triple valves, and which serve to effect the admission of train-pipe air to the brake-cylinder, said parts being the partition separating the valve chamber from the

piston chamber, and the restricted passage through which
1020 auxiliary reservoir air is conducted to the valve chamber of
the triple valve proper; but these additions do not directly effect the admission of train-pipe air to the brake-cylinder, as is the case with the "additional members" of the patent, but merely serve to assist in establishing the momentary differential pressures within the triple valve, and thus render the admission of train-pipe air *through the triple valve* possible. In the one case, that of the patented device, the "additional members" perform all the operations and possess all the requisites for effecting the admission of train-pipe air to the brake-cylinder, and they are added as a whole to the triple valve proper; whereas, in the other case (defendants' triple valve), the changes and additions made are within the triple valve proper, they are incapable alone of performing the function of admitting train-pipe air to the brake-cylinder, and their only function is *to enlarge the capacity of the triple valve* proper, so that *it* may perform the function of admitting train-pipe air to the brake-cylinder at the same time that it admits auxiliary reservoir air to the brake-cylinder, and by the same main valve previously employed in effecting the admission of auxiliary reservoir air alone.

Recess.

In the patented device, the quick-action functions are performed entirely by an "auxiliary valve device" superadded to the triple valve proper; whereas, in defendants' triple valve, the quick-action function is dependent upon the partition and restricted passage *e* (or B) within the triple valve itself.

As I have hereinbefore explained, I understand the 4th claim to include a combination of five elements going to make up a triple-valve device such as that described in the patent. Of the five elements named, but three of them are found in defendants' triple
valve, said three elements including the case, the piston, and
1021 the valves controlling the passages between train-pipe and
auxiliary reservoir, between auxiliary reservoir and brake-cylinder, and between brake-cylinder and atmosphere, constituting the essential elements of the triple valve proper. The fourth and fifth elements of the claim, to wit: "an auxiliary valve actuated by the piston stem" and the "passages leading to connections with a main air pipe and with the brake-cylinder, respectively," which passages are controlled by the auxiliary valve, are not found in the defendants' triple valve. Defendants' triple valves are each provided with the four-valve devices and functions; these are common to the ordinary triple valve and found in the triple valve of the patent, to which last-named triple valve the auxiliary valve and its passage of patent 360,070 are additional members, and are requisite for the purpose of adding the function of direct admission of train-pipe air to the functions of the ordinary triple valve.

The auxiliary valve and the passages controlled thereby are the added elements of the patent 360,070, by which train-pipe air is admitted to the brake-cylinder during and by the movement of

the triple-valve piston; while in defendants' triple valves the partition and restricted passage *e* (or B) are instrumental in producing the momentary differential pressures in the triple valve proper, by which train-pipe air is admitted to the brake-cylinder without the interposition or use of any auxiliary valve.

Referring to each of the three claims under consideration, it is evident that as each one includes a valve which is distinct from the triple valve proper, and auxiliary to main valve thereof, and as the defendants' valves do not employ an additional valve, nor a valve auxiliary to the main valve, they do not make use of the inventions described in claims 1, 2, and 4 of the patent; and, in addition, the principle upon which defendants' valves are constructed and operated is widely different from the principle involved in the patented device.

1022 Such parts of the foregoing answer as express an opinion upon the legal question of infringement are objected to.

Q. 12. You have explained the difference between the mechanical combinations specified in claims 1, 2, and 4 of patent 360,070 in suit, on one hand, and the mechanical combinations contained in the defendants' apparatus on the other hand. Now, please explain whether the principle, or *mode of operation*, of the patented device and the defendants' device is the same or different—giving your reasons with your opinions.

A. The difference in principle or mode of operation is briefly this: The patentee, Mr. Westinghouse, took the old-fashioned triple valve, contrived *an additional valve element*, and compelled the triple valve to actuate this additional valve element so that the latter would admit train-pipe air to the brake-cylinder under certain conditions.

On the other hand, Mr. Boyden, the inventor of the defendants' device, took the form of the old-fashioned triple valve, which had a check-valved feed-passage, and by simply *separating* the piston chamber from the valve chamber and *restricting the passage* through which air flows from the auxiliary reservoir to the valve chamber, he introduced the new principle of "momentary differential air pressures," and thereby compelled the *triple valve itself* to admit train-pipe air to the brake-cylinder without the aid of any auxiliary-valve element whatever.

In admitting train-pipe air to the brake-cylinder the device of Mr. Westinghouse acts on the mechanical principle of employing the triple-valve piston to actuate a new and additional valve element to open the passage from the train-pipe to the brake-cylinder; whereas, the device of Mr. Boyden acts on the entirely different mechanical principle of employing *differential air pressures* to actuate, not a new and additional valve element, but *the triple valve* itself, to open the passage from the train-pipe to the brake-cylinder.

1023 Mr. Westinghouse uses a new and auxiliary valve, not a part of the triple valve; Mr. Boyden utilizes the feed-valve of the old triple valve.

Mr. Westinghouse actuates his new valve by the impact of the triple-valve piston; Mr. Boyden actuates the old feed-valve, such as that of his 1883 patent, by the differential air pressure momentarily established in the triple-valve chamber.

Suppress the auxiliary valve 41, and the port 42 of the Westinghouse device, and there can be no quick action nor admission of train-pipe air directly into the brake-cylinder, although the triple valve will, in other respects, act as before; suppress the partition 9 in the Boyden device, and there can be no quick action nor admission of train-pipe air directly into the brake-cylinder, although the triple valve will, in other respects, act as before. In the one case (Westinghouse device), therefore, the auxiliary valve 41 and its port 42 constitute the quick-action device as distinguished from the old triple valve; in the other case (Boyden device), the partition 9 and its restricted passage *e* (or B) constitute the quick-action device as distinguished from the old triple valve.

It is perfectly obvious that the difference in principle or mode of operation is world-wide between a movable valve and its port, on the one hand, and an immovable partition having a restricted opening through it, on the other hand. This difference of principle, in the two devices under comparison, is fundamental, completely distinguishing the one from the other, having no common analogy or resemblance, and rendering it necessary to assign the two inventions to entirely different classes or categories when looked at from a mechanical point of view.

3.30 p. m.—Adjourned to meet at same place on Monday, May 22d, 1893, at 10.30 a. m.

1024 10.30 A. M., MAY 22D, 1893.

Met pursuant to adjournment.
Parties present as before.

Q. 13. Mr. Boyden, in his testimony, has referred to the fact that certain tests or experiments were recently made at the works of the Boyden Brake Co., in this city, at which you were present. Please give the history of those tests, and state what conclusions are to be drawn from them; giving your reasons.

(Objected to, the practical knowledge of the witness of the subject inquired about not having been shown; he, therefore, being incompetent to testify in regard to experiments and their practical results or bearing upon this case.)

A. The tests referred to were conducted at the works of the Boyden Brake Co., April 25, 1893, and were made for the purpose of demonstrating, practically, that the conversion of the ordinary triple valve into a quick-action triple valve operating on the principle of defendants' was due to the presence of the partition 9 and the restricted passage *e*, or B.

For testing the action of the triple valve there was used an air pump or compressor, a main air reservoir, a section of train-pipe,

an engineers' valve, an auxiliary reservoir, a brake-cylinder and piston, and triple valves such as I shall refer to. The apparatus represented the equipment of a single car, and in the branch pipe connecting the train-pipe and triple valve there was inserted a glass section containing a wooden ball, said glass section being slightly inclined to the horizontal so that the ball would be held against the inlet end, or that nearest the train-pipe, and would be carried up the incline by the admission of train-pipe air through the branch-pipe.

The first experiment involved the use of Defendants' Exhibit B, of which a section is shown in Defendants' Exhibit C. These exhibits illustrate the application of the main valve, with its
1025 graduating valve, of patent No. 220,556 of 1879, used in connection with the piston, partition 9 and feeding-in valve 11 or 26 of defendants' triple valve—the main slide-valve and graduating valve of said patent 220,556 replacing the release, main and graduating valves of defendants' devices; or, to state it another way, the exhibits represent those valves of the patent 220,556 which control the release port and the two lines of communication between the auxiliary reservoir and brake-cylinder, while the actuating piston and feeding-in valve of the patent 220,556 are replaced by the actuating piston and feeding-in valve of defendants' triple valve, together with the partition 9 separating the valve chamber from the piston chamber. In each experiment the auxiliary reservoir was first charged with air at maximum pressure.

Upon slightly and gradually reducing the pressure in train-pipe by means of the engineers' valve, as in making graduated applications of the brake, the piston was moved to close the escape port, open the graduating passage in main valve and unseat the graduating valve; whereupon, auxiliary reservoir air passed to the brake-cylinder, and the reduction of pressure on auxiliary reservoir side of piston occasioned by the expansion of air into the brake-cylinder advanced the piston and closed the graduating valve against its seat, without moving the main valve to uncover the exhaust, thus holding the limited air pressure within the brake-cylinder. A further slight reduction of pressure in the train-pipe served to unseat the graduating valve, thereby admitting more air and increasing the pressure in the brake-cylinder. The re-establishment of maximum pressure in train-pipe forced the piston towards auxiliary reservoir, uncovering the release or exhaust port and re-charging the auxiliary reservoir through the feeding-in valve.

When the pressure in train-pipe was reduced gradually and continuously, by a graduated discharge of air through the graduating port of the engineers' valve, the triple-valve piston operated to first close the exhaust, then open the graduating passage, and
1026 finally to uncover the main port leading from the valve chamber to the brake-cylinder.

When, however, the pressure in train-pipe was suddenly reduced between fifteen and twenty pounds, the triple-valve piston made its full stroke towards the train-pipe side, instantly uncovering the main-port opening from valve chamber to brake-cylinder, and the wooden ball in the glass section of train-pipe was projected towards

the triple valve, thereby demonstrating the fact that *train-pipe air was admitted* to the brake-cylinder through the only avenue open in the triple valve, to wit, through the feeding-in passage to the valve chamber, and thence to the brake-cylinder. Such a movement of the wood ball did not take place in either of the previously described experiments.

The next experiment was made with the same triple valve, Exhibit B, but with the partition or bushing surrounding the hollow stem of the valve piston removed, thus placing the valve chamber in open and unrestricted communication with the auxiliary-reservoir end of piston chamber. The graduated application was made, as before, by a slight reduction of pressure in the train-pipe, and successive graduated applications were made by successive slight reductions of pressure in the train-pipe. When, however, the auxiliary reservoir having been recharged, train-pipe pressure was suddenly reduced from fifteen to twenty pounds, and the piston was suddenly retracted to uncover the passage or port opening from the valve chamber to the brake-cylinder as before, no movement of the wooden ball took place, notwithstanding the fact that the piston of the brake-cylinder was instantly projected; thereby proving that *no* train-pipe air was admitted to the brake-cylinder, and that auxiliary reservoir air *alone* operated in the brake-cylinder.

The next series of experiments were performed with defendants' Exhibit A, representing the quick-action triple valve of defendants' 1891 catalogue. The apparatus employed was the same as
1027 used in the preceding experiments, Exhibit A being substituted for Exhibit B.

The Exhibit A was first used in its complete condition, and, the auxiliary reservoir being charged and maximum pressure established in train-pipe, a slight and gradual reduction of pressure being effected in train-pipe through the engineers' valve, the triple-valve piston was retracted until the shoulder on the stem engaged main valve 22, thereby closing the release port and opening communication between valve chamber and brake-cylinder through the graduating port. As the pressure of auxiliary reservoir air diminished by expansion into the brake-cylinder, the valve piston moved towards the auxiliary reservoir side until the graduating port entered the main valve, and was closed thereby. A further slight reduction in pressure in train-pipe operated to withdraw the graduating port temporarily from within the main valve and effect a further admission of auxiliary reservoir air to the brake-cylinder. A slow and continuous discharge of air from the train-pipe through the graduating port of the engineers' valve, by which the gradual reduction of pressure in the train-pipe was effected, operated upon the piston of the triple valve to first close the release valve, then open the graduating valve, and finally unseat the main valve. During these operations no movement of the wooden ball was observed.

When the pressure in train-pipe was suddenly and considerably reduced—say from fifteen to twenty pounds—the piston of the triple valve was instantly moved its full stroke, closing the release port and unseating the main valve, and *the wooden ball was instantly*

driven toward the triple valve, thus showing that air from the train-pipe had entered the brake-cylinder by the only passage through which it could enter, to wit, the feeding-in passage, valve chamber and port uncovered by the main valve.

In the fourth experiment Exhibit A was again used, but *without the bushing or partition* which surrounds the hollow valve
1028 stem, and which before served to separate the valve chamber from the auxiliary reservoir end of piston chamber; this placed the valve chamber in open and free communication with the auxiliary reservoir. The action of the apparatus was unchanged so far as the operations of graduating were concerned; that is to say, when the pressure in train-pipe was slowly and slightly reduced, or slowly and considerably reduced. But when the pressure in train-pipe was suddenly and considerably reduced, the valve piston made its full stroke, closing the release valve and unseating the main valve, thereby quickly charging the brake-cylinder from the auxiliary reservoir alone and without any admission of train-pipe air, as shown by the wooden ball, the latter remaining in position at the train-pipe end of the glass section.

In the fifth experiment the partition was inserted, and the graduating valve removed, which was done by substituting a blank stem, *i. e.*, one having no graduating port or passage. With the triple valve thus altered and *deprived of its separate graduating valve*, graduated applications were made by slow and partial reductions of pressure in the train-pipe, the main valve of the triple valve being but slightly moved from its seat, so that but a limited passage was opened through which auxiliary reservoir air was gradually admitted to the brake-cylinder. When, however, the pressure in train-pipe was suddenly and considerably lowered, the piston of the triple valve made its full stroke, moving the main valve from its seat, and opening wide the large port leading from the valve chamber to the brake-cylinder, and the ball in the glass cylinder was instantly projected towards the triple valve, showing that train-pipe air had entered the triple valve and been discharged into the brake-cylinder.

The sixth experiment was performed with Exhibit A, containing the blank stem as in the fifth, but with the partition removed, and the valve chamber in open and unrestricted communication with the auxiliary reservoir. Graduated applications of pressure in the brake-cylinder were performed as in the fifth experiment, the main valve being but slightly raised from its seat. When the
1029 pressure was suddenly and considerably reduced in the train-pipe, the valve piston made a full stroke, unseating the main valve and opening wide the large port leading to the brake-cylinder; whereupon, air from the auxiliary reservoir was instantly discharged into the brake-cylinder, as indicated by the movement of the brake piston, but no train-pipe air was admitted, the wooden ball remaining stationary.

These experiments confirmed the views I have expressed, and satisfactorily demonstrated the fact that the *separation* of the valve chamber from the auxiliary reservoir end of the piston chamber,

and the *restricted passage* through which auxiliary reservoir air is conducted to the valve chamber, *constitute the quick-action elements* of the Boyden quick-action triple valve, and that the introduction of the principle of "momentary differential pressures" is all that distinguishes the Boyden quick-action triple valve from the ordinary triple valve, and from the triple valve proper of patent No. 360,070.

The experiments made with Exhibit B serve to demonstrate the fact that the particular form of triple valve proper illustrated in patents 360,070 and 220,556 perform the same operations and are generically the equivalent of Mr. Boyden's triple valve when the quick-action principle of momentary differential pressures, invented by Mr. Boyden, is absent, as when the partition and restricted passage are omitted.

Comparing Exhibit B without partition, and Exhibit A without partition, each exhibits all the elements of an ordinary or plain triple valve; that is to say, each has a controlling piston, a feeding-in valve, a release or exhaust valve, a graduating valve and a main valve, and each is adapted to perform graduated applications of pressure and quick applications of pressure, but without the admission of train-pipe air directly to the brake-cylinder. When, however, the bushing or partition and restricted passage are introduced, each of said ordinary triple valves is at once converted into a

quick-action triple valve without further change or modifi-
1030 cation in structure, or the addition of any new valve element.

Recess.

The experiments made with Exhibit A when deprived of its graduating valve by the introduction of the blank stem, demonstrate two things: First, that the removal of the graduating valve converts the triple valve into one of the kind known and used prior to 1879, as exhibited; for example, in the Westinghouse patents Nos. 141,685 of 1873, 144,006 of 1873, 168,359 of 1875, and 172,064 of 1876, and the Jones patent No. 166,386 of 1875, in all of which the main valve is used for both graduating and full applications of pressure; thus the main valve of Exhibit A is similar in construction and mode of operation to the main valves of patents 141,645 and 144,006, equivalents of which are found in the main slide-valves of patents 168,359 and 172,064; and, secondly, that the old triple valve, with its main valve performing both the graduating and full applications of pressure, is converted into a quick-action taiple valve by the introduction of the partition or bushing and the restricted passage between auxiliary reservoir and valve chamber.

The experiments further demonstrate that in the Boyden triple valve the valve marked 22 in defendants' 1891 catalogue, is the main valve controlling the flow of air between auxiliary reservoir and brake-cylinder; that the graduating valve, formed by the port 40 and passage in the piston stem, performs part of the function which would be performed by the main valve in the absence of the graduating valve, and to this extent contains the improvement in-

troduced by patent No. 220,556 of 1879, wherein the graduating valve was made to perform those parts of the main-valve functions which pertain to graduation; that all of the functions pertaining to the triple valve proper, whether provided with a separate graduating valve or not, are performed just the same in the ab-
1031 sence of the quick-action features as with the quick-action features added; and that by the addition of the partition or bushing and the restricted passage, and without otherwise changing the functions of the old triple valve, the admission of train-pipe air is effected, and the old triple-valve mechanism is thereby converted into what is now known as a "quick-action triple valve."

During the experiments made with Exhibits A and B, the positions occupied by the main and graduating valves, and by the main valves when the graduating valve was omitted, were observed through the glass windows inserted in the casings of said exhibits.

The answer is objected to generally, as stating nothing pertinent to the issue; and specifically as predicated upon experiments made with a disconnected and incomplete apparatus and not a full train equipment; as based upon certain tests made with devices having an element or elements foreign to the triple valve practically used by the defendants; and upon other tests made with devices having omitted therefrom an element or elements necessarily entering into the defendants' triple valve.

Q. 14. The complainants' expert, Mr. Newbury, in his testimony in this cause, has endeavored to establish the theory that the main valve 22, of the defendants' triple valve, is to be regarded as the mechanical equivalent of the auxiliary valve 41 of the patent in suit, and that it does not correspond to the main valve H of the Westinghouse patent No. 220,556. What comments have you to make on Mr. Newbury's theory?

A. Mr. Newbury has sought to convey the impression in his testimony that the quick-action triple valve of patent 360,070 is adapted to perform three classes of work, namely, "graduating," "service stop" and "emergency stops," and that the ordinary triple valve, whether of the form shown in patent No. 220,556 or other known form, is capable of performing but two of the three enumerated classes of work, to wit, "graduating" and "service stops."
1032 In my opinion, Mr. Newbury is in error, and the facts do not justify his conclusions.

The ordinary triple valve is constructed and adapted to perform all of the operations included under the three-fold classification, and the difference between the operation of the quick-action triple valve and the ordinary or plain triple valve of the 1879 patent is one of degree.

In so far as the action of the ordinary or plain triple valve is concerned, in effecting the application of the brake, there are practically but two classes of work performed, and into these time and pressure enter as the distinguishing elements. The two are: First, maximum pressure and minimum time, effected by opening communi-

cation between the auxiliary reservoir and brake cylinder *instantly*, and utilizing auxiliary reservoir pressure *fully* in the brake-cylinder; and, secondly, a more gradual application of pressure, performed in a longer period of time, and effected by a gradual, intermittent, or continuous discharge of air from the auxiliary reservoir into the brake-cylinder. Take, for example, the ordinary triple valve as exhibited in patents No. 220,556 of 1879 and No. 172,064 of 1876; if an emergency arise, demanding that the brake be *instantly applied with full power*, to effect a sudden stoppage of the train, the pressure of air is suddenly and considerably or entirely reduced in the train-pipe, with the result that the piston of the triple valve makes its full stroke, uncovering and holding open the passage C from the valve-chamber to the brake-cylinder, and permitting the auxiliary reservoir air to flow directly into the brake-cylinder until the pressures are equalized; these are the conditions and operations performed in making the quickest stop possible with such apparatus; it is known as an "emergency stop." To effect an application of the brakes less sudden and violent than the emergency stop, as in slowing up or making an ordinary service stop, the brakes are applied by a gradual intermittent or continuous admission of auxiliary reservoir air to the brake-cylinder,
1033 according to the work to be performed; but in every such case, whether the result be a full or partial application of the braking force, a longer interval is required. Thus, if it is desired to apply the brakes while running down grade, a slight and gradual reduction of pressure is made in the train-pipe, and a graduated quantity of air is discharged from the auxiliary reservoir into the brake cylinder *by graduation*, which is effected by such reductions of pressure in the train-pipe as will open the graduating passage in the main valve of the 1879 patent, or so far retract the main valve of the 1876 patent as to only partially and temporarily uncover the passage leading to the brake-cylinder. The amount of pressure thus applied in the brake-cylinder may be increased by successive graduations, or by a continuous discharge of auxiliary reservoir air through the graduating passage, or the restricted opening formed by the partial uncovering of the port by the main valve; but in either event a longer interval of time must elapse before the pressure in brake-cylinder equalizes with that in the auxiliary reservoir, than in the case of an emergency stop. Now, the amount of pressure required or employed for checking the speed of the train, or bringing it to a full stop, depends largely upon circumstances—it may require the maximum of auxiliary reservoir air, or any degree under that; and as all applications of the brakes with less than the maximum power, when performed in the shortest possible time, are subject to the control of the engineer, both as to degree of power and time of application, they are properly classed as graduating operations, whether for retarding or stopping the train.

According to Mr. Newbury's classification, the gradual application of pressure is "graduating" when employed to reduce the speed of the train without stopping it, and is a "service stop" if the train is stopped; and he has entirely ignored the action of the

ordinary triple valve *when used in an emergency* or when "automatically" operated to apply the brakes with maximum power in the shortest possible time.

1034 If Mr. Newbury's classification is adopted, it must be with the understanding that the third class, to wit: "emergency stops," are performed by the old triple valve just as much as by the quick-action triple valve, and that the only difference between the emergency stop of the quick-action triple valve and that of the ordinary triple valve has relation to the *increase* in power and the *quicker* serial application of the brakes on the train of cars.

Take, for example, the triple valve of patent No. 220,556 as employed in the patent 360,070. When an emergency stop is made by the sudden and considerable reduction of pressure in the train-pipe, the piston of the triple valve instantly makes the full stroke and opens direct communication between the auxiliary reservoir and brake-cylinder. In the absence of the auxiliary-valve device of patent 360,070, this would represent the condition under which maximum pressure could be applied in the shortest possible time, and the only difference effected by the auxiliary-valve members is the utilization of a portion of the train-pipe air in the brake-cylinder, and the depletion of the train-pipe, to quicken the action of the triple valve on the next succeeding car. Under these circumstances, the action of the triple valve proper in performing an "emergency stop" is the same whether the auxiliary-valve members are present or not, and when present, the maximum power developed is *increased* by the admission of train-pipe air and the serial action of the several triple valves in the train is *quickened*.

In referring to the defendants' quick-action triple valve, Mr. Newbury has again ignored the third class of work, to wit: "emergency stops," as properly belonging to the triple valve proper. Defining the triple valve proper as one capable of performing the two classes of work which he calls "graduating" and "service stops" (which classes of work I have termed "graduating," inasmuch as they are performed through the medium of the graduating valve, or the main valve when operated to partly or temporarily
1035 uncover its port), he has selected the graduating valve 40 of defendants' 1891 catalogue, and the graduating valve 13 of defendants' 1889 catalogue, and, properly attributing those two classes of work to the performance of said graduating valve, he has undertaken to say that said graduating valves are the main valves, and that the valve 22 is a valve auxiliary to *his so-called main valve*, whose function it is to open communication between the train-pipe and the brake-cylinder.

I most emphatically disagree with Mr. Newbury on this point, and my reasons are as follows:

First. The graduating valve of defendants' quick-action triple valve performs *only* the function of the graduating valve of patent 220,556, while the main valve 22 performs the functions of the main valve H in said patent when operated to uncover the passage leading to the brake-cylinder. The graduating valve in defendants' triple valve operates during the first portion of the stroke of piston, to

effect a gradual admission of air to the brake-cylinder, as does the graduating or auxiliary valve of patent 220,556; the main valve 22 is unseated during the latter portion of the full stroke of the piston, and is held removed from its port to allow the free passage of auxiliary reservoir air to the brake-cylinder, just as is the main valve H of patent 220,556, moved to uncover its port during the latter part of the full stroke of its piston.

Remove the graduating valve in defendants' device, and the graduating valve of patent 220,556, and all the graduating functions will be performed in both by the main valve, as in patent 172,064 of 1876, as well as the functions performed in effecting an emergency stop.

Adjourned to meet at same place on Tuesday, May 23rd, 1893, at 10.30 o'clock a. m.

10.30 A. M., MAY 23RD, 1893.

Met pursuant to adjournment.

Present: J. Snowden Bell, Esq., of counsel for complainants, and same counsel as before on behalf of defendants.

1036 Second. The main valve 22 of defendants' quick-action triple valve is situated in the direct line of communication between the auxiliary reservoir and brake-cylinder, and is the valve opened during the last portion of the stroke of valve piston, and it is the medium by which communication between the auxiliary reservoir and brake-cylinder is opened when the brakes are "automatically" applied, corresponding *in all these particulars* with the main valve of the ordinary triple valve, whether provided with a separate graduating valve or not.

Third. The main valve 22 of defendants' device can in no sense be considered as *auxiliary* to the triple valve proper of which it forms a component part; nor can it be regarded as in any sense auxiliary to a triple valve proper of the kind illustrated in patent 360,070, containing *both a main and a graduating valve* for admitting air from the auxiliary reservoir, to the brake-cylinder.

Mr. Newbury appears to have practically ignored the fact that the triple valve proper, of patent 360,070, (it being the triple valve proper known as the "ordinary" or "plain triple valve" and exhibited in patent 220,556) contains *two* valve devices controlling admission of auxiliary reservoir air to the brake-cylinder, the one represented by the graduating valve and the other represented by the main valve to which the graduating valve is "auxiliary" in the sense that it performs *part* of the functions previously performed by the main valve of prior structures; and, further, that the auxiliary valve device of patent 360,070 is *auxiliary* to and supplements the action of an ordinary or plain triple valve containing both the main and graduating valve. Inasmuch as the graduating valve of defendants' triple valve performs the ordinary graduating functions, and the main valve, so far as it controls communication between the auxiliary reservoir and brake-cylinder, performs substantially the same function in this particular as does the main valve of the ordinary triple valve shown in patent 360,070, said main valve 22

in defendants' triple valve cannot properly be said to be *an*
1037 *auxiliary valve device,* or a valve device *auxiliary* to itself simply because advantage is taken of its normal operation to bring about the momentary differential pressures by which the admission of train-pipe air is induced and rendered possible.

Q. 15. Is a braking force, which is just sufficient to stop a train of cars running at a given speed on a level track, sufficient to stop the same train, running at the same speed, on a down grade?

(The foregoing question, while included in the general objection of incompetency first entered during the deposition of this witness, is more particularly objected to as being an entirely improper attempt to establish, by the theories of one not shown to have any practical knowledge whatever of the subject-matter, some view of counsel, the correctness or incorrectness of which can only be properly shown by the testimony of those who can and do give the results of actual experience and practical tests as matters of absolute fact, and not in anywise matters of mere theory.)

A. No; and this illustrates the absurdity of Mr. Newbury's classification of work performed by the ordinary triple valve, for, all the conditions being the same (the pressure in the brake-cylinder being the same and the engineers' valve operated the same), when running down the hill without stopping, the work performed would, according to Mr. Newbury, be "graduation," and the same work performed on a level, and resulting in the stoppage of the train, would be classed as a "service stop." In each case there would be a *graduated* application of the pressure, and the results would differ by reason of the different conditions under which the brakes were applied.

Defendants' counsel offers in evidence, to be marked Defendants' Exhibit Westinghouse 1890 Instruction Book, the instruction book referred to by Mr. Church in his answer to the tenth interrogatory.

1038 Also, to be marked Defendants' Exhibit Westinghouse 1886 Instruction Book, the instruction book referred to by Mr. Church in his answer to the sixth interrogatory.

Also, Defendants' Exhibit No. 141,685, a copy of the patent issued to George Westinghouse, Jr., dated August 12, 1873, No. 141,685.

Also, as Defendants' Exhibit No. 166,386, a copy of the patent issued to W. D. Jones, dated August 3, 1875, numbered 166,386.

Also, as Defendants' Exhibit No. 166,405, a copy of the patent issued to H. L. Perrine, dated August 3, 1875, and numbered 166,405.

Also, Defendants' Exhibit No. 172,064, a copy of the patent issued to G. Westinghouse, Jr., dated January 11, 1876, and numbered 172,064.

Also, as Defendants' Exhibit No. 235,922, a copy of the patent issued to George Westinghouse, Jr., dated December 28, 1880, and numbered 235,922.

Also, as Defendants' Exhibit No. 243,415, a copy of the patent

issued to George Westinghouse, Jr., dated June 28, 1881, and numbered 243,415.

The patent exhibits above referred to are copies of the specifications and drawings printed by the Government, but do not contain the patent head.

It is stipulated by and between the counsel for complainants and defendants, respectively, that the several exhibits which have been or may be offered in evidence by the parties to this cause, may be retained in the custody of the party offering them, subject at all times to the inspection of the opposite party, his counsel or experts, until the hearing of the cause.

Cross-examination *de bene esse* by J. Snowden Bell, Esq., of counsel for complainants, reserving objections taken:

Counsel for complainants gives notice that at or prior to the hearing motion will be made to strike from the record the entire
1039 deposition of the witness, as being incompetent and unwarranted in this cause, and proceeds with the cross-examination, subject to such notice and the objections heretofore taken.

Counsel for defendants gives notice that at or prior to the hearing motion will be made to strike from the record the entire deposition of the complainants' expert, so called, Mr. Henry F. Newbury, upon exactly the same grounds upon which the complainants' counsel objects to the deposition of Mr. Church—both experts having apparently the same qualifications, so far as concerns their practical experience in the matter of air brakes.

16 X Q. In view of the close correspondence between the theories enunciated by you in your deposition-in-chief and those of defendants' witness, George A. Boyden, who immediately preceded you, it would seem that prior to giving your deposition you had made yourself fully familiar with that of Mr. Boyden. Is this the fact?

A. I have frequently consulted with Mr. Boyden on the subject of air brakes generally, and especially with reference to the subject-matter of this case, and was present during most of Mr. Boyden's examination and cross-examination, and to this extent your assumption is correct.

17 X Q. Your answer seems to embody some sort of a qualification. Is it not the fact that you are and were at the time of commencing your deposition fully familiar with that of Mr. Boyden?

A. I may say that I think I am fully acquainted with what Mr. Boyden testified to, and was familiar with it at the time my testimony commenced, having heard most of it given.

18 X Q. Such being the fact, please state whether you agree with or differ from the several theories and opinions enunciated by Mr. Boyden in his direct and cross-examination, and if you shall say you differ from him, please indicate in what particular or particulars.

(Objected to, as an improper mode of cross-examination.
1040 Counsel should point out the particular "theory" to which he refers, and if he refers to several, he should specifically

point out each, and direct the witness' attention to them. It is not proper to ask the witness to analyze a deposition of some hundreds of pages in answer to a question of this indefinite and unusual character; and defendants' counsel instructs the witness that he is not obliged to answer the question unless complainants' counsel shall state or point out the particular alleged "theories" to which he refers.)

(Counsel for complainants, protesting against the above instruction to the witness as being an attempted violation of the right of cross-examination, states that he refers to *all* the several theories and opinions enunciated by Mr. Boyden in his direct and cross-examination, and submits to the court that in view of the perfect familiarity of the witness with the deposition of Mr. Boyden, as indicated not only by the close correspondence of the witness' expressed views with those expressed by Mr. Boyden, but also of the witness' own admission, he deemed it wholly unnecessary and nothing but a waste of time to rehearse *seriatim* Mr. Boyden's theories and opinions.)

(Defendants' counsel renews his objections and instruction. He does not question the right of complainants' counsel to cross examine as to the agreement or disagreement of this witness with the testimony of Mr. Boyden; but he does question the right of complainants' counsel to throw a whole deposition at the witness at once, and require him to study it over and find every theory or opinion in it, and comment upon it. If he wants to know whether the witness agrees or disagrees in any particular theory expressed by Mr. Boyden, he should find the theory himself and call attention to it in his interrogatory.)

1041 A. I have not so carefully analyzed and reviewed Mr. Boyden's testimony as to enable me at this time to separate and classify those parts referred to as his opinions and theories, but I believe that, taken as a whole, his deposition is correct.

19 X Q. In order to refresh your weakened recollection, I will refer you to Mr. Boyden's answer to X Q. 193, and ask you whether or not you believe that answer to be correct.

(Objected to, on the ground that complainants' counsel has not, in his interrogatory, called attention to any alleged "theory" of Mr. Boyden, but to an answer given by Mr. Boyden to a question calling for a mere statement of fact, and not theories. Also further objected to as indefinite and obscure. If this interrogatory means to ask the witness whether Mr. Boyden was correct in testifying to what he "intended" by his "answer 7," then the question is further objected to as incompetent, because this witness is not qualified to state what Mr. Boyden intended by his answer 7, as referred to in cross-interrogatory 193 of Mr. Boyden's deposition.)

A. I have examined Mr. Boyden's answer to X Q. 193 in connection with the question to which it has reference, and I find both question and answer to relate to two subjects of inquiry. The first subject has reference to counsel's understanding of a statement

contained in answer 8 of Mr. Boyden's deposition, wherein the latter says that he had reference to his patent No. 280,285 when he stated that his 1883 patent was not for what is now known as a quick-action valve. I believe Mr. Boyden's statement concerning counsel's understanding of this branch of the question to be correct, and the fact to be as stated.

The second subject relates to a further understanding of counsel to the effect that a certain statement concerning the valve device of plate XI defendants' 1891 catalogue, was not intended by the witness, Mr. Boyden, to mean certain things stated in the
1042 question X Q. 193; and I believe Mr. Boyden's answer, both
as to counsel's understanding and the witness' intention, was correct. As to the fact, I would say that the valve device *plate of* XI, defendants' 1891 catalogue, belongs to the class of what are now known as quick-action triple valves. The triple valve of patent No. 280,285 does not fall within the category of what is now known as the quick-action triple valve, nor does it operate to effect the application of the brake with maximum rapidity and force by or through a primary and direct admission of train-pipe air to the brake-cylinder as the result of a reduction of train-pipe pressure; but it does contain and exhibit a triple-valve device provided with a check-valved feeding-in passage through which the train-pipe air is conducted both to the auxiliary reservoir, when feeding, and to the brake-cylinder, direct when applying pressure, and it also contains a main valve controlling the admission of both auxiliary reservoir air and train-pipe air to the brake-cylinder.

Recess.

20 X Q. In view of your last preceding answer I presume you will agree with me the following statement which I quote from the inset printed in red ink commencing page 2 of defendants' 1891 catalogue is an incorrect and untrue statement, to wit:

"*The Boyden Quick-action Valve.*

"One of the features of this valve is the provision for passing compressed air to the brake-cylinder direct from the train-pipe in automatic brakes. This feature is covered by U. S. patent issued to George A. Boyden, June 26th, 1883, and reissued April 2nd, 1889, No. 10993. For the said feature this is the foundation patent."

Am I correct?

(Objected to as immaterial, irrelevant and incompetent. The issue in this suit is not upon the claim of the Boyden patent originally issued June 26th, 1883, and reissued April 2nd, 1889,
1043 but upon the Westinghouse patent No. 360,070. The passage
quoted by counsel does not declare that said Boyden patent is for a quick-action valve, but that it contains a feature which it does cover and for which it is the foundation patent; and then continuing, it gives a copy of two claims contained in the reissue and covering that feature. The validity of those claims is not in

any way in question in this suit, and it is altogether improper and irrelevant to extend the cross-examination into such an inquiry, especially as the subject of the inquiry forms no part of the examination-in-chief.)

(Counsel for complainants objects to and protests against the plain instructions to the witness contained in the foregoing objection of defendants' counsel.)

A. I do not observe that the statement quoted is necessarily incorrect and untrue. On the contrary, it would appear to be a correct statement, so far as I have examined into the subject of the Boyden reissue patent mentioned in the quotation.

21 X Q. The frequent consultations with Mr. Boyden with reference to the subject-matter of this case, mentioned in your answer 16, were held prior to the commencement of Mr. Boyden's deposition in this case, were they not?

A. Most of them were.

22 X Q. Did Mr. Boyden consult or confer with you relative to the subject-matter of his deposition during the progress of said deposition or during the adjournments that were made from time to time therein?

A. I cannot say that he did, although the subject-matter of this case has frequently been referred to and various matters discussed. If you mean to imply that I in any way, directly or indirectly, influenced Mr. Boyden's testimony while he was on the stand, I answer decidedly that I did not to the best of my knowledge and belief.

1044 23 X Q. I do not mean to *imply* anything, but simply want to inquire whether or not any communications were had between yourself and Mr. Boyden during the pendency of his deposition in this cause in, from or by which he received from you any advice, information or suggestions bearing upon the subject-matter of his testimony. If I have made the question sufficiently plain, I would be glad if you will answer it, with the understanding that I consider Mr. Boyden's deposition as pending until he has signed it and left the stand.

A. I have talked with Mr. Boyden in a general way, but to a very limited extent, about his testimony, having reference to testimony given and not to testimony to be given at any period during his examination, and such conversations as I have had, have been during the lunch recess, and have not been in the nature of advice, information or suggestions proceeding from me, but have been, so far as I can remember, more in the nature of requests on my part for information as to the meaning of his answers, and as to facts pertaining to the practical use and operation of the defendants' quick-action triple valve. I do not call to mind any occasion or any conversation in which I gave Mr. Boyden any advice, information or suggestion bearing upon the subject-matter of his testimony, or which did or could influence the same.

24 X Q. Are you willing to answer and will you answer X Q. 23 categorically in the negative?

A. I am unable to answer it categorically for the reason that I do not know whether or not anything I may have said, may have been of such a nature as to have operated upon Mr. Boyden's mind as advice, information or suggestion; but I do know this, that whatever I may have said in general conversation was not intended and I do not believe operated to affect Mr. Boyden's testimony.

25 X Q. Was not your object, in making the requests to Mr. Boyden, "for information as to the meaning of his answers, and as to facts pertaining to the practical use and operation of the
1045 defendants' quick-action triple valve," referred to in your answer to X Q. 23, to enable yourself to state to the court as *your* testimony, such information as to the subject-matter of Mr. Boyden's answers and the defendants' quick-action valve as you might derive from hearsay statements of Mr. Boyden. If this was *not* your object please state what your object was in making these requests.

A. Such was *not* my object. Some of Mr. Boyden's answers were obscure, to my understanding, and I may have asked him what he meant; and the requests for information as to facts pertaining to the practical use and operation of defendants' quick-action triple valve had reference particularly to the triple valve of defendants' 1889 catalogue, a sample of which I do not remember to have seen, although I have understood from the beginning that it contained more than one passage *e*. As the drawing referred to shows but a single passage *e*, I questioned Mr. Boyden to ascertain if my recollection and understanding was correct in this that the triple valve as actually constructed by the defendants did in fact contain more than one such passage, and did involve the principle of "momentary differential pressures;" to which Mr. Boyden replied in the affirmative. I do not now recall asking for any information or obtaining any facts with which I was not previously acquainted. So far as I was aware no inhibition has been placed upon Mr. Boyden or myself concerning the discussion of the subject-matter of this suit, and had there been I should probably have been notified of the fact, and would then have refrained entirely from any discussion of the subject-matter of this suit while Mr. Boyden remained upon the stand.

26 X Q. Then as I understand your last preceding answer, your statements-in-chief as to the quick-action triple valve of defendants' 1889 catalogue instead of being wholly statements of facts within your own knowledge, are partially based upon hearsay, to wit, information received from Mr. Boyden. Is this the fact?

A. They are partially based upon the testimony given by
1046 Mr. Boyden concerning the actual construction and arrangement of parts in the triple valve *as actually made* by the defendants and represented in the 1889 catalogue.

27 X Q. Do you understand it to be your duty or your right when assuming to testify as a mechanical expert to clear up the obscurity of the answers of another witness, and more particularly when you are not interrogated as to the correctness of his answers?

A. I do, if by so doing I can throw light on the subject under consideration, and concerning which I have been interrogated.

But in the present case I have merely sought to make clear and distinct my meaning and understanding, and I do not know that I have cleared up the obscurity of the answers of another witness.

28 X Q. At and prior to the time that you began to request information from Mr. Boyden as to the meaning of his answers, and as to facts pertaining to the practical use and operation of defendants' quick-action triple valve, as stated in your answer 23, had your readings and studies on the subject of air brakes been limited to such a degree that it was necessarry for you to get this information from Mr. Boyden in order to enable you to testify as a mechanical expert?

A. It had not, and I merely asked him, to confirm my information on the subject.

29 X Q. Referring now to your consultations with Mr. Boyden prior to the commencement of his deposition, were the views and opinions expressed by Mr. Boyden derived from information or advice to such effect imparted by you to him in such consultations?

A. I have had, during the past two years, several extended consultations and discussions of the matters involved in this suit with Mr. Boyden and Mr. Mann, and I have also had consultations with Mr. Hill, defendants' counsel. During these discussions and consultations there has been a full and free interchange of opinion between all parties, and a practically unanimous conclusion has been reached.

I am unable to say who first suggested or mentioned their
1047 views or opinions concerning the construction of the patent
in suit or of the infringement thereof by the defendants. My present recollection is that when I was first requested to examine the patent in suit in connection with Mr. Newbury's deposition and defendants' 1889 and 1891 catalogues, and after having the defendants' triple valves explained to me, I at once reached the conclusion and expressed the opinion that defendants' triple valves involved a mode of operation differing from the patent, and that they did not infringe upon the claims of the patent.

(Answer objected to by counsel for complainant- as not responsive.)

30 X Q. X Q. 29 repeated.

A. I do not know, and the reason is stated in my last preceding answer.

31 X Q. Are the views and opinions expressed by you in chief original with yourself, or were they derived from or based upon information, advice or suggestions to the effect expressed in such views and opinions, from Mr. Boyden or from any other person?

A. I am unable to separate and distinguish my individual views and opinions as distinguished from such as have a basis on information derived from other sources and resulting from my reading, study and discussion of the subject with other parties. The views I have expressed are my views and opinions based upon a careful consideration of the whole subject with all the information I could obtain. Mr. Boyden and myself have entertained substantially the same views on the subject of non-infringement from the first, and

we have been so much in accord that I am unable to distinguish any particular theory or opinion as the property of either.

32 X Q. Coming now to a single instance is the theory as to "momentary differential pressures" presented by you in your deposition original with yourself, or is it derived from a theory to such effect communicated to you by Mr. Boyden or any other
1048 person, or from the reading of a patent or any other source exterior to yourself?

A. I regard it as the law controlling the operation of defendants' valve, and as involved in a correct understanding of said triple valve and its mode of operation. I am unable to state at this time whether, in explaining the operation of the defendants' valve mechanism, Mr. Boyden or Mr. Mann suggested this law, or whether I discovered it upon investigating the subject with a view to ascertain the principle involved in the operation of defendants' quick-action triple valve, as distinguished from the ordinary triple valve, possessing apparently the same number of valves. It is quite possible that either Mr. Boyden or Mr. Mann may have directed my attention to the subject at our first interview, which occurred nearly two years ago.

33 X Q. Upon more careful consideration are you not perfectly sure that the expression "momentary differential pressures" was not original with you, but was coined by somebody else, and that the theory which that expression indicates was not original with you, but was presented to you by somebody else?

A. The expression "momentary differential pressures" was, I think, coined by some one else, suggested to me and adopted as an apt one to describe the principle of operation embodied in defendants' apparatus; but as to the theory of operation, I am unable to say whether or not some one did first suggest it to me, or whether I worked it out for myself.

34 X Q. Referring to your answer to question 2, it is the fact, is it not, that you "participated" in a large number of air-brake tests and experiments conducted or superintended by Mr. George A. Boyden only to the extent of witnessing Mr. Boyden manipulate the handle of an engineers' brake-valve while making experiments upon a testing rack, or elsewhere in the shop?

A. The tests and experiments referred to were made in the shop on different occasions during the past two years. In some of them Mr. Boyden operated the engineers' valve, and in others some
1049 one else in the shop manipulated the engineers' valve according to instructions given either by Mr. Boyden or myself. On some occasions the triple valve used was taken off and the interior mechanism examined, and in the last tests made with Exhibits A and B the valves were repeatedly removed from the casing, and, when in operation, the movements of the valves were observed through the glass window in the side of the casing, Mr. Boyden or myself directing an assistant, I don't know who it was, stationed at the engineers' valve, to graduate or produce quick action as desired.

$34\frac{1}{2}$ X Q. Your observation of the shop tests at the works of the

Boyden Brake Co. as to which you have testified constitutes the sum total of your practical experience in connection with air brakes, does it not?

A. It does, outside of observations made with respect to the actions of the brake mechanism on running trains supposed to be equipped with quick-action triple valves.

35 X Q. The "observations" referred to in your last preceding answer were, I presume, simply such observations as could be made by yourself or any other traveller when riding in a railroad car, and were not specially conducted observations made in a trip or series of trips?

A. For the most part they were such as *might* be made by most travellers who are much of the time on railway cars, and they also include observations made during the trials of an exhibition train equipped by the Westinghouse Air-brake Co. and exhibited on the railroad at or near Falls Church, Va.

36 X Q. In your answer to question 8 referring to patent 360,070, after describing the operation of the mechanism in applying the brakes by the admission of reservoir air through the port controlled by the graduating valve, you next go on to say:

"When, however, the pressure in train-pipe was suddenly and considerably reduced, either by the engineer, or automatically, by the braking of the train, or the bursting of the train-pipe, the
1050 preponderance of auxiliary reservoir air pressure upon the piston of the triple valve would carry said piston, and the valve connected thereto, its full stroke, and in so doing would drive back the graduating stem and carry the graduating port 31 in main valve beyond the port or passage 23, through which latter, communication was before made with the brake-cylinder, thereby opening communication between the auxiliary reservoir and brake-cylinder through a passage 35 in the end of the main valve."

Doubtless through inadvertence, or possibly under the pressure of a desire to conform to the views expressed by Mr. Boyden, you omitted to mention that the operation described in the foregoing quotation takes place when, and only when, air is admitted directly from the main air pipe to the brake-cylinder through the port governed by the valve 41; or, in other words, when the parts are moved into a position to effect a quick-action application.

What you omitted to state, and what I have stated above, is strictly true, is it not?

A. The description quoted was preceded by a statement that the operations performed "in *the absence* of the new elements and functions added to the triple valve" would be the same as the operation of the triple valve described in patent 220,556. Those operations are referred to in the passage quoted, and are the operation performed by the triple valve proper of patent 220,556. The admission of train-pipe air described in the question is performed by the newly added elements or "additional members" of patent 360,070, and inasmuch as said newly added elements are so connected with the operation of the triple valve proper that the same movement of the piston which brings port 35 into communication with the port or

passage 23 also moves the auxiliary valve 41 to uncover its port 42, it of course follows that if there be sufficient pressure remaining in the train-pipe to unseat the check-valve 49, air from the train-pipe will enter through port 42; but if the air in train-pipe is in-
1051 stantly discharged, no air will enter through port 42, notwithstanding the fact that the valve 41 has been moved to uncover said port.

(Answer objected to by counsel for complainants as not responsive, and as being a volunteered reiteration by the witness of a theory formulated by Mr. Boyden, and not supported by a scintilla of evidence as to what might happen under certain conditions not referred to, even by remote implication, either in question 8 or in cross-question 36.)

37 X Q. X Q. 36 repeated, witness' attention being directed to the fact that he was not asked, either in question 8 or in X Q. 36, what could, or would, or might be the case if the device of patent 360,070 was something different from what it is, and that he is asked simply as to the mechanism as described and shown in said patent, and as to the normal and described operation of such mechanism?

A. I must confess that without the explanation I should not and did not understand X Q. 36 to have reference to any other operation than that described and referred to in the paragraph quoted; and as said paragraph is but part of an answer, I found it necessary to call attention to the statement preceding the explanation given in the quoted paragraph.

If the entire mechanism of patent 360,070 is included, and the conditions under which it is used are such as will retain an effective pressure in train-pipe, after the triple-valve piston is fully retracted, and the passages 35 and 42 opened, train-pipe air will undoubtedly be admitted slightly in advance of the admission of auxiliary reservoir air.

(Same objection.)

38 X Q. X Q. 37 repeated and a categorical answer requested.

A. It is true that I omitted to mention that the operation described in the paragraph quoted in X Q. 36 takes place when and only when air is admitted directly from the main air pipe to the brake-cylinder through the port governed by the valve 41,
1052 and it is equally true that the omission was intentional on my part, because that function and operation pertains to the *added mechanism;* and it was not through inadvertence or under the pressure of a desire to conform to the views expressed by Mr. Boyden that I made such omission. What I omitted, and what you have stated in question 36, is undoubtedly a fact when referring "to the mechanism as described and shown in said patent and as to the normal and described operation of such mechanism" under the conditions mentioned in my last preceding answer.

39 X Q. In your answer to question 8 you speak of the operations performed by the device described in patent No. 217,838, July 22, 1879. Do your reading, studies or observations extend far enough

to enable you to know whether the device described in patent 217,838 ever performed any operations whatever or whether such a device was ever constructed?

A. I have no direct personal knowledge of the construction or use of the device described in the patent mentioned, although I have heard that devices similar in their action, and operating to vent the train-pipe at different points for assisting in reducing the pressure in train-pipe, and hastening the serial action of the triple valves, have been employed, but my knowledge on this point is hearsay only.

All of the answer subsequent to the word mentioned as hearsay objected to by counsel for complainant- as hearsay.

40 X Q. Do your reading, studies or observations extend far enough to enable you to venture an opinion as to whether or not the device described in patent No. 217,838, is a practical and workable device or one capable of useful operation in a brake system? Please bear in mind that I am asking about the device as it is and not what it might be changed into in the light of subsequent invention.

1053 Objected to as immaterial, irrelevant and incompetent. The patent in question having been taken out by complainants and not being involved in this suit, it is hardly competent to discuss its validity in this suit, or for the complainants to deny the operativeness of what they have patented as an operative invention.

Counsel for complainants suggests that the question goes only to the sufficiency of the patent for the purpose for which defendants have lugged it into their testimony.

A. I am of the opinion that a mechanic skilled in the art would be able to construct and use the device described in patent No. 217,838, and to make it work practically for useful operation in a brake system, but whether its operation would be satisfactory in all respects and under all conditions and to all parties I am unable to say.

41 X Q. Do you claim to be a mechanic skilled in this art or in any other branch of the mechanic arts, and do you, as such, enunciate the opinion given in your last preceding answer?

A. I do claim to be something of a mechanic and to have some knowledge of mechanics; but I have not given careful consideration to the proposition, but have relied upon the patent and the statements contained in the patent as true in fact.

Answer objected to by counsel for complainants as not responsive.

42 X Q. X Q. 41 repeated, and a categorical answer requested.

A. My answer to X Q. 40 is not based upon a critical examination of the patent as to the practical and useful qualities of the device, but is based upon the assumption that what the patent states

is true and that Mr. Westinghouse was sufficiently qualified to make the statements found in the patent.

Same objection.

43 X Q. Do you claim to be a mechanic skilled in the art to which patent No. 217,838 relates or in any other branch of the mechanic arts, and if you do, please state the nature and
1054 extent of your mechanical training and experience in whatever art you may claim to be skilled in?

A. My experience has been almost exclusively confined to theoretical mechanics, and has had to do with a great many branches of mechanical arts and has not been specially directed to any particular branch, except as occasion required. I do not claim to be what may be termed a practical mechanic in the art to which patent 217,838 relates.

Same objection.

44 X Q. Could not X Q. 43 have been truthfully answered categorically in the negative?

A. It might with the understanding stated in my last preceding answer.

Same objection.

45 X Q. X Q. 43 repeated, and categorical answer requested.

A. I do. My principal experience and training was in the Patent Office when I had charge of the class of metal-working machinery, and, subsequently, when I had charge of the classes of harvesting and milling machinery.

Objected to as volunteering a statement of the witness' qualifications as a theorist and student which has nothing whatever to do with the operations of a practical mechanic or a skilled mechanic.

46 X Q. Please state for the information of the court the art or arts in which you claim to be a skilled mechanic, the length of your apprenticeship thereto, the manufacturing establishment or establishments in which you have worked, the character of the work you did, kind of tools and machines you worked with and the length of time you spent in acquiring whatever skill you may claim to possess.

This line of cross-examination objected to as simply wasting the time, the witness having already stated the facts fully to the court.

A. So far as actual manual labor is concerned I have never
1055 served an apprenticeship in any manufacturing establishment, nor have I ever worked as a day laborer. I entered the Patent Office when I was 19 years of age and remained there 11 years. During a large portion of this time I was in charge of the class of metal-working machinery; considered, passed upon, allowed or rejected many hundreds, and I may say thousands of applications for patents, all of them involving principles of mechanics as embodied in all kinds of machines for working upon metal from

rolling mills down to pin-making machines, and during this time I made frequent visits to various manufacturing establishments for the purpose of informing myself in mechanical operations and processes. It was a part of my duty to study and understand patents and publications descriptive of mechanical devices and to determine their operativeness.

The same kind of experience I had when in charge of the classes of harvesting and milling, including all harvesting implements from automatic grain-grinders to lawn mowers and scythes, and all the mechanical devices employed in milling.

Subsequently, as examiner of interferences, I was called upon to consider and decide upon questions involving the mechanics of almost every branch of art included in patents.

The Patent Office was the establishment in which I labored and gained most of the information I possess respecting mechanics, mechanical arts, and the construction of patents.

All of the last preceding answers after the word "establishment" in the first sentence thereof, objected to as not responsive and a labored irrelevant argument, the witness not having been asked anything about the work of a day laborer, with which he seems to confound a mechanic, or of a Patent Office examiner, and being only asked as to his qualifications, if any, as a *mechanic*.

47 X Q. You say you never worked as a "day laborer."
1056 Did you ever work as a *mechanic*, if so, where, for how long and in what branch of the mechanic arts?

A. I have not, other than as stated in my last preceding answer.

48 X Q. Please state specifically for the information of the court where in your last preceding answer you have stated that you worked a day or an hour as a *mechanic*.

Objected to as before.

A. I regard much of the labor performed while an examiner in the Patent Office as being the labor of a mechanic; not performed manually with tools and implements, but mentally, with drawings, descriptions and models.

Objected to by counsel for complainants as being merely an irresponsive volunteered argument, wasting time and seeking to avoid a full disclosure of the facts to the court.

Defendants' counsel replies to this objection that the witness has stated the facts over and over again, and that, not content with the facts, complainants' counsel has allowed his cross-examination to degenerate into a mere badgering match, wasting time, to the annoyance of everybody and the advantage of nobody.

Counsel for complainants regrets that a sense of professional duty prevents him from permitting defendants' counsel to conduct both the direct and cross examination of the witness.

49 X Q. Have you received an education in any technical school or college, and if so, in which, and for what period?

A. I have not.

50 X Q. In your answer to question 10 referring to defendants' quick-action triple valve, plate IX, 1889 catalogue, you say:

"To apply the brakes with full power in the shortest possible time, as in making an emergency stop, or in automatically applying the brakes, the pressure of air on the train-pipe side of
1057 the piston is suddenly or entirely reduced, and the piston, under the influence of auxiliary reservoir pressure, will be caused to make its full stroke toward the train-pipe, thereby instantly withdrawing the piston valve 15 from the port 16 and opening a relatively large passage through which air from auxiliary reservoir will flow to the brake-cylinder."

Do you wish the court to understand that at the same time air from the train-pipe will pass to the brake-cylinder, and if you do not, please state whether you find your warrant for the statement I have quoted in the description of the device given in defendants' 1889 catalogue, in patent No. 481,134, with which Mr. Boyden says said valve accords, in information received from Mr. Boyden or any one else, or in any other source exterior to yourself.

A. I wish the court to understand, as plainly stated in my answer to which reference is made in the question, that the operation described in the paragraph quoted will be the operation of the apparatus if the valve chamber is in open and unrestricted communication with the auxiliary reservoir, which fact or condition was intended to be implied and is stated in the paragraph preceding the quotation, wherein I say "omitting from consideration the relative proportions of the several passages, and the separation of the valve chamber, *d*, from the auxiliary reservoir end of the piston chamber, and assuming that a free and full communication was provided between the auxiliary reservoir and valve chamber, so that the pressure of air in said valve chamber would at all times equal that in the auxiliary reservoir." *It was under these conditions* that the action would be as stated in the paragraph quoted in the question. With the *partition* and *restricted passage* present in the device, train-pipe air would be admitted, as fully explained further on in my answer 10.

(In view of the failure of the witness to adduce evidence of the possession of the qualifications requisite under the law for a
1058 mechanical expert, counsel for complainants declines to cross-examine him as to the merits of the issue in this cause, and here closes the cross-examination.)

JOSEPH B. CHURCH.

10 A. M., WEDNESDAY, *May 24th*, 1893.

Met pursuant to adjournment; parties present as before.

Redirect examination of Mr. GEORGE A. BOYDEN by LYSANDER HILL, Esq., of counsel for defendants:

(NOTE.—Mr. Boyden's testimony-in-chief begins on page 17 and terminates on page 148.)

R. D. Q. 236. During the taking of the testimony in this case, mention has frequently been made of an application of the brakes

called an "emergency application," or "emergency stop," and also of an application termed the "automatic" application; please explain these terms so that the court can distinguish between them.

Objected to as not proper redirect examination.

A. My understanding of the terms is that *emergency* application means to apply the brakes by venting the main air pipe either at the engineers' valve or by the conductors' valve located in the cars, said operations being performed *manually*, in case it is desired to stop the train as quickly as possible, in cases of emergency.

As to the term "automatic application" of the brakes, my understanding of this term is that it means an application of the brakes *mechanically;* that is to say, in case of the hose connections bursting, or the train separating, the train-pipe would be vented "automatically" instead of by *manual* action, thereby automatically applying the brakes.

R. D. Q. 237. In your cross-examination, the relation of the
1059 port or passage 35, of the patent in suit, to the function of "quick action" was discussed at great length. In order to render such relation clear, assume that, in the triple valve of said patent, No. 360,070, without making any other changes, the port or passage 35 were plugged so as to become incapable of performing any function whatever, and state what would be the practical result.

A. If a quick application of the brakes were made, and the port 35 was plugged up so that no air could pass through it, the result would be to practically destroy the efficiency of the brake in making said quick action, as in such a case only train-pipe air would pass to the brake-cylinder, except what little would pass through the graduating valve while the port 31 quickly passed over the port 23. By such an action, the reservoir air would not be admitted to the brake-cylinder, and in the absence of said reservoir pressure, there would not be sufficient pressure contained in the brake-cylinder to exert a sufficient braking force to quickly stop the train.

R. D. Q. 238. Assuming the train-pipe and auxiliary reservoirs to be charged with the normal working pressure of seventy pounds, and a "quick-action" stop to be then made by suddenly reducing the train-pipe pressure twenty pounds, which of the ports or passages, 42 or 35, of the patent in suit, would as a matter of fact, admit the greater amount of air pressure to the brake-cylinder in making such stop.

A. Undoubtedly the port 35; as the air from the auxiliary reservoir, which passes through the port 35, exerts a pressure of about fifty pounds to the square inch on the piston in the brake-cylinder, whereas the pressure from the train-pipe, which passes through port or passage 42, exerts about ten pounds pressure on the piston in the brake-cylinder, making, in all, about sixty pounds.

R. D. Q. 239. In the specification of patent No. 360,070, page 4, lines 39 to 42 inclusive, I find a statement that the air so taken from the train-pipe will exert a pressure of about twenty-five
1060 pounds in the brake-cylinders; this statement does not ap-

pear to be consistent with the statement in your last answer, and therefore I will ask you to inform the court which of the two statements is substantially correct?

Objected to as not proper redirect examination.

A. My opinion and observation is that when the brake first takes the quick action, if a gauge was placed on the brake-cylinder, it would instantly jump to or register twenty or twenty-five pounds pressure, indicating that there was about 25 pounds pressure passed from the train-pipe to the brake-cylinder at this stage of the operation of the brake; therefore my opinion is that that is what is meant in the patent specification in the lines referred to.

In making an application of the brakes (not a quick-action) the reservoir pressure would exert about fifty pounds on the piston in the brake-cylinder, but when making a *quick* application of the brake there would be about ten pounds more exerted on the piston over that exerted from the auxiliary reservoir pressure alone, making in all about sixty pounds pressure. However, the length of the stroke in the piston in the brake cylinder has considerable to do with the total pressures; the shorter the stroke the greater the pressure exerted and the longer the stroke the less the pressure exerted.

R. D. Q. 240. In your cross-examination, complainants' counsel seemed to question one of your statements, which statement was to the effect that, in the triple valve of patent No. 220,556, if, by the discharge of air from the train-pipe, the triple-valve piston be caused to make a full stroke, as in cases of emergency and automatic application, the main valve H will uncover the port C and permit auxiliary reservoir air to flow freely past the end of said valve, through the port C, into the brake-cylinder. Have you, since your cross-examination was concluded, made any tests or experiments with said triple valve of patent No. 220,556, to prove whether your said statement was correct, or not? If yea, please explain said tests and the results which they demonstrated.

1061 A. Yes, I have taken a Westinghouse triple valve made in substantial accord with patent 220,556, and put a glass side in it and connected the same with the brake-cylinder and auxiliary reservoir and engineers' valve and storage tank, and it operated in accordance with my statement. The operations of the valve were as follows: The whole was charged with seventy pounds pressure and the engineers' valve actuated to discharge a small amount of main air-pipe pressure. This shifted the valve parts and admitted auxiliary reservoir air to the brake-cylinder through the graduating valve. This operation was repeated several times, and each time the graduating valve was opened and admitted a small amount of auxiliary reservoir air into the brake-cylinder. The operation of the graduating valve was observed through the glass window in the side of the valve case.

The whole device was again charged with seventy pounds pressure, and the engineers' valve manipulated to discharge a considerable amount of air from the train-pipe. This instantly shifted the piston in the valve mechanism the full stroke, and the slide-valve

wholly uncovered the port C, thereby quickly and fully applying the reservoir pressure to the brake-cylinder through the said port C. This operation was repeated several times, and each time the performances were alike as stated, the said operation being observed through the glass window in the side of the valve.

In making the last tests, the engineers' valve was manipulated the same as when making an "emergency" application of the brakes.

R. D. Q. 241. Have you here present the Westinghouse triple valve with which you made the tests or experiments described in your last answer?

A. I have; it is now on the table and can be distinguished as having a round disc connected to it by pipe connections, and a glass window in the side of the valve casing.

Defendants' counsel offers said triple valve in evidence, to be marked "Defendants' Exhibit D."

1062 Defendants' counsel states that as the witnesses, Mr. Boyden and Mr. Church, have testified to several experiments and tests, made at the shops of the Boyden Brake Company in Baltimore, on April 25th, 1893, with the exhibits here in evidence, marked "Defendants' Exhibit A" and "Defendants' Exhibit B," respectively, and Mr. Boyden has now testified to further experiments and tests subsequently made by him at the same place with "Defendants' Exhibit D," defendants counsel now tenders and offers to the complainants' counsel a repetition of said tests and experiments, at the same place and under the same conditions as the original tests, if he shall desire to witness them; and requests an intimation from him or his desire in that respect.

Or, if complainants' counsel shall so desire, Mr. Boyden will, at any reasonable time and upon due notice, repeat said tests and experiments in the presence of complainants' counsel and experts.

Counsel for complainants, expressing his appreciation of the courtesy and fairness of the offer made by defendants' counsel, does not deem it necessary, as at present advised, to accept it. If, however, at a later date, he is able to secure the attendance of his expert, and should consider that it would be desirable for the fuller information of the court that these experiments, or any or either of them, should be repeated, he will so advise defendants' counsel, and if an engagement can be made to suit the mutual convenience of the parties, will be glad to attend with his experts for the purpose.

1063 Recross-examination by J. SNOWDEN BELL, Esq., of counsel for complainants:

X Q. 242. Are the statements made in your answers to R. D. Q.'s 237 and 238, statements of your opinions, or do you make them as statements of facts within your knowledge, demonstrated by carefully conducted and recorded experiments or tests?

A. They are statements of my opinions.

G. A. BOYDEN.

Defendants rest. And defendants' counsel gives notice to complainants' counsel that the defendants desire to have this cause got ready for trial at the fall term of this court.

Counsel for complainants replies that he will proceed with testimony in reply as early as is compatible with a careful examination and conference with his experts on the voluminous record presented on behalf of defendants, and with the conduct of such practical tests and experiments as such examination may indicate to be necessary preliminary to the taking of testimony in reply. He also reminds counsel for defendants that complainants' testimony in chief closed on August 19th, 1891.

Defendants' counsel reminds counsel for the complainants that the replication is dated February 28th, 1890, and that the delay of complainants in making out their *prima facie* case, and the delay of the defendants in completing their answering evidence, were about equal, and were acquiesced in by both parties for good and substantial reasons, as counsel supposes. At all events, those delays furnish no reason for delaying the case hereafter, and it is the defendants' desire that it shall be brought to trial as speedily as possible.

1064 Counsel for complainants has not the slightest desire or intention to delay the case, and shall only ask for a sufficient amount of time to enable him to properly prepare and present complainants' testimony in reply.

Defendants' counsel states that he thinks it would, perhaps, be advisable to ask the court to fix the time for closing the evidence in this cause; and therefore he now gives notice to complainants' counsel that on Monday, June 5, 1893, at 10 o'clock a. m., or as soon thereafter as counsel can be heard, at the court-room of the United States circuit court in the city of Baltimore, Maryland, the defendants will make application to his honor, Judge Morris, or such other judge of said court as may then and there be present and acting, to assign a date within which the complainants shall conclude their evidence in reply. In doing this, it is not the intention of defendants' counsel to seek to abridge in any way the reasonable time due to the complainants for concluding their evidence, but merely fix some time within which the evidence may be concluded, so that, if possible, this cause may be tried at the fall term.

Counsel for complainants acknowledges service of the above notice, and will attend at the time and place designated.

1065 & 1066 (*Court Order.*)

WESTINGHOUSE BRAKE CO.
vs.
BOYDEN BRAKE CO.
} Circuit Ct. of United States, Dist. of Md.

Ordered by the court this 5th day of June that the complainants close their testimony in rebuttal on or before December 1, 1893.

THOS. J. MORRIS, *Judge.*

UNITED STATES OF AMERICA, *District of Maryland*, } *To wit:*

I, James W. Chew, clerk of the circuit court of the United States for the district of Maryland, do certify the foregoing to be a true copy of the original order, passed on the 5th day of June, 1893, in the above-entitled cause.

[SEAL.] In testimony whereof, I hereunto set my hand and affix the seal of said court this 21st day of June, A. D. 1893.

JAS. W. CHEW, *Clerk.*

1067 United States Circuit Court in the District of Maryland.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY
vs.
BOYDEN POWER BRAKE CO.; GEORGE A. Boyden, President; Charles B. Mann, Secretary; William Whitridge, Treasurer.
} In Equity. No. 321.

I, George Morris Bond, a United States commissioner as aforesaid, before whom the within depositions were taken, do hereby certify that on the 26th day of April, 1893, and on the various days adjourned therefrom, ending on the 24th day of May, 1893, I was attended by counsel of the complainants and defendants in the above-entitled cause and by the witnesses, George A. Boyden and Joseph B. Church, and that each witness was by me duly sworn, and the testimony by him given was then reduced to writing, and thereafter subscribed by the said witnesses.

And I do further certify that I am not of counsel or attorney for either of the parties to the said cause, and that I am not interested in the event of the said cause.

[COM'R'S SEAL.] Given under my hand and seal at the city of Baltimore, within the district of Maryland, this twenty-fourth day of May, in the year of our Lord one thousand eight hundred and ninety-three.

GEORGE MORRIS BOND,
U. S. Commissioner for Maryland.

1068 United States Circuit Court, District of Maryland.

GEORGE WESTINGHOUSE, JR., and WESTINGHOUSE AIR BRAKE COMPANY
vs.
BOYDEN POWER BRAKE CO. *et als.*

1. The defendant- respectfully represents to the court that the last testimony taken by the plaintiffs in this case, which testimony was taken in rebuttal and with which the plaintiff- closed *its* case, introduced an issue which had not been previously introduced into

the case, and of which the defendants had no notice when the testimony-in-chief was taken.

2. That for the proper presentation of the case to the court and the proper defence of this case, it is necessary that the defendants should be permitted to introduce evidence in the nature of sur-rebuttal.

3. That the defendants is prepared to take such testimony without delay—and that the taking of the same will cause little if any delay in bringing the cause to a hearing—which these defendants are most anxious to do.

4. That the defendants therefore pray the court to pass an order permitting the defendants to take testimony in reply to the testimony of the plaintiffs above referred to, provided reasonable notice of the taking of said testimony be served upon the counsel of the plaintiffs and provided the taking of such testimony be
1069 closed within such time as may be fixed by this honorable court.

And as in duty bound, etc.

SKIPWITH WILMER,
Sol. for Defendants.

Sworn to by George A. Boyden before me this 17th day of March, 1894.

JAS. W. CHEW, *Clerk.*

Ordered by the court this 17th day of March, 1894, that the defendants have leave to take the testimony as prayed in the foregoing petition, provided that at least ten days' notice of such taking be served upon the solicitors of the plaintiffs and that the defendants close their testimony finally within thirty days from the date of this order and the testimony so taken be subject to all legal exceptions.

THOMAS J. MORRIS, *Judge.*

UNITED STATES OF AMERICA, *District of Maryland,* } *To wit:*

I, James W. Chew, clerk of the circuit court of the United States for the district of Maryland, do certify that the foregoing is a true copy of the petition and order of court thereon now on file among the proceedings in the above-entitled cause.

[SEAL.] In testimony whereof I hereto set my hand and affix the seal of said circuit court his 17th day of March, 1894.

JAS. W. CHEW, *Clerk.*

1070 United States Circuit Court, District of Maryland.

GEORGE WESTINGHOUSE, JR., *et al.*
vs.
BOYDEN POWER BRAKE CO. *et al.* } In Equity. No. 321.

And now, to wit: March 27th, 1894, come the complainants, and move the court that the order made by the Honorable Thomas

J. Morris, judge, under date of March 17th, 1894, granting leave to the defendants to take testimony as prayed in their petition, sworn to by George A. Boyden, on the date of said order be vacated.

The following reasons are assigned in support of the motion:

1. That the said order was granted upon an *ex parte* application of the defendants, and without notice to complainants or opportunity for them to be heard in opposition to the petition for said order.

2. That the only material allegation of the petition upon which said order was granted, to wit, that the complainants' testimony in reply "introduced an issue which had not been previously introduced into the case, and of which the defendant- had no notice when the testimony-in-chief was taken," is untrue and incorrect, both in law and in fact.

3. That the defendants were represented by counsel throughout the taking of the complainants' testimony in reply, and that said counsel failed to interpose any objection whatever to said testimony on the ground that it introduced a new issue, or an issue of which they had not theretofore had notice, and that they are therefore estopped to now make the allegation that such an issue had been introduced.

1071 4. That the petition on which said order was granted fails to specify or set forth in any manner whatever, the nature, character and extent of the issue which it alleges was introduced, and that the allegation of such introduction is so broad and general, that the order imposes no restriction whatever (except as to time and notice) upon the defendants in the taking of testimony thereunder.

5. That the said order subjects the complainants to undue expense in attending testimony of the defendants which is unwarranted by the complainants' testimony in reply.

6. That the said order makes no provision for the taking of testimony by complainants in reply to such additional testimony as may be taken by defendants under the said order.

GEORGE H. CHRISTY,
J. SNOWDEN BELL,
BERNARD CARTER,
Solicitors for Plaintiffs.

UNITED STATES OF AMERICA, *District of Maryland,* } *sct:*

J. Snowden Bell, being duly sworn, deposes and says, that he is an attorney and counsellor at law, and of counsel for complainants in the above cause; that the taking of the complainants' testimony was conducted by him throughout, and that he is familiar with the same, as well as with the testimony of the defendants; that having full knowledge of the matters set forth in the foregoing motion, the same are true to the best of his knowledge, information and belief.

—— ——.

Sworn to and subscribed before me this 26th day of March, A. D. 1894.

ISAAC BROOKS, JR.

1072 United States Circuit Court, District of Maryland.

GEORGE WESTINGHOUSE, JR., *et al.*
vs. } In Equity.
BOYDEN POWER BRAKE CO. *et al.*

It is this 26th day of March, 1894, ordered by the court that the above motion stand for hearing at 12 o'clock, noon, on Thursday, March 29th, 1894, provided a copy of said motion and of this order be served on one of the solicitors for the defendants, on or before March 27th, 1894.

THOMAS J. MORRIS, *Judge.*

United States Circuit Court, District of Maryland.

GEORGE WESTINGHOUSE, JR., *et al.*
vs.
BOYDEN POWER BRAKE CO. *et al.*

In explanation of the order of March 17th, 1894, permitting defendants to take surrebuttal testimony it is now, to wit, March 29th, 1894, further ordered that said testimony shall be strictly limited to proof of the operativeness of a device constructed in accordance with the Westinghouse patent, No. 217,838, July 22, 1879, and fur-
1073 ther that complainants shall have thirty days from the date of closing said surrebuttal testimony to take testimony in reply thereto, and in all other respects the said order of the 17th of March, 1894, remains in force.

(Signed) THOS. J. MORRIS, *Judge.*

GEORGE WESTINGHOUSE, JR., and WESTINGHOUSE AIR BRAKE CO.
vs.
BOYDEN POWER BRAKE CO. *et als.*

BALTIMORE, MARYLAND, *March* 21, 1894.

Mr. J. Snowden Bell, counsel for the Westinghouse Air Brake Company, Pittsburgh, Pennsylvania.

DEAR SIR: You are hereby notified that on Wednesday, April 4, 1894, at 10.30 a. m., at room 544, Equitable building, in the city of Baltimore, and State of Maryland, counsel for defendants will proceed to take testimony on behalf of defendants in the nature of surrebuttal.

The taking of testimony will continue from day to day until complete. You are invited to attend and cross-examine.

Herewith please find a certified copy of the order of the court permitting this testimony to be taken.

Very respectfully, SKIPWITH WILMER,
Counsel for Defendants.

Service under order as amended March 29th, 1894, acknowledged this 29th day of March, 1894.

J. SNOWDEN BELL,
Of Counsel for Complainants.

1074 United States Circuit Court for the District of Maryland.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY
vs.
BOYDEN POWER BRAKE COMPANY; GEORGE A. Boyden, President; Charles B. Mann, Secretary, and William Whitridge, Treasurer.
} In Equity. No. 321.

In accordance with an order of the court, signed by his honor, Judge Morris, on March 17, 1894, which order was based on a petition of defendants, and a further order dated March 29, 1894, based on a motion made by complainants, and which explained the first order, defendants were given permission to take testimony in the nature of surrebuttal to prove the operativeness of devices constructed in accordance with the Westinghouse patent, No. 217,838, dated July 22nd, 1879.

Deposition- of witnesses and other evidence in surrebuttal on behalf of defendants in the above-entitled cause, taken under the above order as amended, pursuant to notice, before G. Morris Bond, United States commissioner, at the office, No. 544 Equitable building, Baltimore, commencing on Wednesday, April 4, 1894, at 10.30 a. m.

Present, Charles B. Mann, Esq., of counsel for defendants, and J. Snowden Bell, Esq., of counsel for complainants.

1075 GEORGE A. BOYDEN, being recalled, deposes and says in answer to interrogatories propounded to him by Charles B. Mann, Esq., counsel for defendants, as follows, to wit:

243 Q. Are you the same George A. Boyden who has heretofore testified in this cause?

A. I am.

244 Q. Have you read that part of the deposition of complainants' witness, Henry F. Newbury, printed in Complainants' Record on pages 287 and 288 in answer to question 223?

A. I have, and I understand therefrom that Mr. Newbury denies the operativeness and usefulness of the device shown in patent 217,838, dated July 22, 1879, in which I do not agree with Mr. Newbury in any particular.

So much of the foregoing answer as succeeds the words "I have" are objected to by counsel for complainants, as not responsive, and a volunteered statement of the witness.

246 Q. The said question 223 relates to the operativeness of devices constructed in accordance with patent 217,838 of July 22, 1879. I now ask you whether you have taken any steps to test the accuracy or truth of the several statements made by Mr. Newbury denying the operativeness of that device?

Objected to, as irrelevant, immaterial and incompetent under the

pleadings in this cause, which objection is continued without further notice as to the entire line of examination relative to the operativeness of a device constructed in accordance with patent 217,838.

A. I have, and I have carefully considered patent 217,838, and in order to show on what I base my understanding of the operativeness of the device shown in that patent I will quote several paragraphs from the specifications:

1076 First quotation:

"The present device is more especially designed for use with and as a part of brake apparatus of the class commonly represented by the Westinghouse automatic brake, in which the brake power available for immediate use in the brake-cylinders is contained in auxiliary reservoirs, one under each car."

The above quotation refers to what is known as an "automatic air brake," in which the essential elements are, first, a train-pipe; a brake-cylinder, an auxiliary reservoir, and a triple valve. These four elements were old prior to 1879, the same being shown in a drawing I now submit in evidence, and marked "Defendants' Exhibit Drawing of Automatic Brake, 1879." See Fig. 14. This drawing also shows the valve device of patent 217,838, located in the hose coupling and designated by the letter E.

(Here follows diagram marked p. 1077.)

Second quotation:

"It sometimes happens with such brake apparatus, especially in a case of accident, that material advantage could be effected by having all the brakes of the train applied or brought into action simultaneously, or as nearly so as possible. To accomplish this it is only necessary to make provision for the simultaneous opening of one or more ports in the air conduit passages at points not remote from each auxiliary reservoir. For this purpose I arrange at such various parts of the air conduit or communicating pipes as may be desired, but by preference at the couplings, relief valve of the kind shown in the drawings."

This quotation refers to a desirable result that is to be produced in automatic brakes by introducing the new element in addition to the train-pipe; brake-cylinder; auxiliary reservoir; and triple valve which forms the automatic brake as previously used. This new device being a *valve element* to open ports throughout
1079 the train-pipe, and *thereby rapidly deplete the pressure therein to quicken the application of the several brakes throughout the train* in case of accident, or for other purposes.

Third quotation:

"By arranging such valve boxes at several points along the communicating pipe, each section of that pipe becomes relieved from pressure almost immediately on the section in front of it being relieved, and consequently the several sets of brakes throughout the train, are put in action without the loss of time, which would be involved if, for the relief of pressure throughout the pipe, the air

contained in the hinder portions of it had to flow all the way to the escape aperture, which might be near its front part, and is usually on the locomotive."

This quotation refers to the mode of operation, and explains that by relieving each section of train-pipe (a "section" implying a car's length) of its pressure by the new *valve element* placed therein, that the following sections of pipe will be almost immediately relieved of their pressure and *the application of the brakes throughout the train made much quicker than if all the air pressure had to be discharged, by the old method, at the engineers' valve.*

Fourth quotation:

"The same device may be applied at any part of the communicating pipe, *p*, by making therein, across the bore of the pipe, a ported diaphragm, *o*, Fig. 3, such as is used in ordinary stop-cocks, and arranging therein a relief valve of the construction described, as shown in Fig. 3."

This quotation elucidates the fact that the new *valve element* can or may be placed in any part of the train-pipe; and therefore is not confined to any particular location so long as it is suitably arranged therein.

1080 Fifth quotation:

"The form or construction of the relief valve, its function and operation being substantially the same, may be varied considerably, in so far as it is an element in the described combination, without any material departure from the scope of the invention."

This quotation specifies that the *valve element* may be constructed in a variety of ways so long as the function and the operation is retained.

Sixth quotation:

"In the present invention the escape valve enters into combination not only with the brake-cylinder but also with the auxiliary reservoir."

This quotation sets forth that the new *valve element* not only enters into combination with the brake-cylinder but also with the auxiliary reservoir, and as the train-pipe and the triple valve are also essential elements to the brake-cylinder and auxiliary reservoir, they too are in the same combination, making in all five essential elements in the device shown in patent 217,838, four of which are old, and the fifth being the new *valve element.*

The above quotations show conclusively to my mind what the operativeness of the device of patent 217,838, is, and *that the result thereof is to quicken the action of the old automatic brake as used prior to* 1879.

The mode of operation to quicken the action of the automatic brake as disclosed in patent 217,838 of 1879, is the fundamental law which governs all quick-action brakes of today, namely: that of depleting the train-pipe of its pressure "at points not remote from each auxiliary reservoir."

It is true that the patent 360,070 of 1887 in suit, shows other means for executing this fundamental law of the patent 217,838, but nevertheless the operativeness of depleting the train-pipe of its

pressure at points other than the engineers' valve is the essential operating feature of patent 217,838, and of all other quick-acting brakes since that time, including patent in suit, and is there-
1081 fore the pioneer patent for quickening the action of the several brakes throughout the train.

So much of the foregoing answer as assumes to state "the fundamental law which governs all quick-action brakes of today," and discuss patent 360,070 in suit, objected to by the counsel for complainants, first, as wholly irresponsive, and an unwarranted volunteered statement of the witness, and second as being unwarranted by and wholly at variance with the order of court by and under which this testimony is taken, which order distinctly and in terms specified that this testimony should be limited strictly to proof of the *operativeness* of a device constructed in accordance with patent 217,838.

In order to avoid the delay of an application to the court to restrain further violation of its order by the interjection of testimony wholly foreign to that prescribed in said order, counsel for complainants now and hereby requests counsel for defendants to instruct the witness to refrain and desist from making further irresponsive statements involving matters foreign to that prescribed by said order of court, and gives notice that unless the witness shall desist from so doing he will require the examiner to certify the deposition to the court, and apply to the court for a further order preventing these or other violations of the present order.

Counsel for defendants replies that it is his purpose to take testimony only relevant to the operativeness of devices constructed in accordance with patent No. 217,838, of July 22, 1879. That in order to present this testimony intelligently to the court, it is necessary to show by the witness what is his understanding of the device described in that patent, and how that device operates. Having elicited from the witness what his understanding of that pat-
1082 ent is, counsel now proposes to ask him what further steps he took to demonstrate the operativeness of the device in question.

Counsel for defendants states to the witness that his responses to questions put to him should be confined to matters relative to the operativeness of devices constructed according to patent 217,838.

Counsel for complainants replies that the questions heretofore put by counsel for defendants have been entirely proper and fully in accord with the order of the court as is his intention just expressed relating to his further examination. The objection of counsel for complainants was based solely on the irresponsive matter, unwarranted by the court's order, which was interjected by the witness into his answer, and as counsel for complainants now understands counsel for defendants concurs with him in directing that such departure from the limits of the order shall not be hereafter allowed.

Counsel for defendants replies that he suggested to the witness that he should confine his responses to matters relative to the operativeness of the device in question in compliance with the request

made by counsel for complainants that he should do so, and he thus complied in order to have his position on this subject understood and in order to avoid any cavil on the point.

Defendants' counsel offers in evidence the following exhibits, to wit:

A valve device, marked "Defendants' Exhibit Westinghouse Valve, Patent No. 217,838, July 22, 1879."

A section of a valve device marked "Defendants' Exhibit Section Westinghouse Valve, Patent No. 217,838, July 22, 1879."

A valve device marked "Defendants' Exhibit Westinghouse Valve, Patent No. 217,838, July 22, 1879, Attached to Angle Cock."

1085 247 Q. Having stated how you understand patent No. 217,838 of July 22, 1879, I now ask what further steps did you take to ascertain the operativeness of the device shown and described in that patent?

A. I took the patent and after carefully studying it I selected therefrom Fig. 1 (see Fig. 15 this record) as a true representation of the device of the said patent. I then made a working drawing from said Fig. 1 of such proportions that the device I was going to have made could be screwed or attached to the regular hose coupling in use, in order that I might try the device on our testing rack. A copy of the device of patent 217,838 shown in this working drawing I now submit in evidence, marked "Defendants' Exhibit Copy of Working Drawing, Patent 217,838." (See Fig. 16.) This drawing of the device is made exactly like that in the working drawing from which the devices marked "Defendants' Exhibit Westinghouse Patent No. 217,838, July 22, 1879," and section of valve device, marked "Defendants' Exhibit Section of Westinghouse Valve, Patent No. 217,838, July 22, 1879," and also the valves I used to test the operations of the device of said patent, were made.

(Here follows diagram marked p. 1084.)

The counsel for defendants, offers in evidence the two drawings heretofore submitted by the witness, one marked "Defendants' Exhibit Drawing of Automatic Brake, 1879," (Fig. 14,) and the other marked "Defendants' Exhibit Copy of Working Drawing, Patent 217,838, July 22, 1879." (Fig. 16.)

"Defendants' Exhibit Copy of Working Drawing, Patent 217,838, July 22, 1879," objected to as secondary evidence, the original working drawing from which the metal exhibits are alleged to be made being the best evidence, and counsel for complainants calls upon counsel for defendants to produce and offer said original drawing in evidence.

Counsel for defendants states that the original drawing, of which a copy has just been offered in evidence, will be put in evidence.

1086 From the working drawing I had patterns made, and from the patterns had castings made and valves fitted up the same as "Defendants' Exhibit Westinghouse Valve, Patent No.

Fig. 1,

"Defendants' Exhib

Compressed Air is

Compressed Air pass
from this Aperture
the rear portion of Tra

[illegible]

217,838, July 22, 1879," and "Defendants' Exhibit Section of Westinghouse Valve, Patent No. 217,838, July 22, 1879," in fact the exhibit marked "Westinghouse Valve" is one which was taken from the rack, and was used in making the tests. These valves are made in strict accordance with the working drawing, and with patent 217,838.

I first made one valve and tried it, and found it to work as set forth in the patent. After this, I made 12 more, and finally made 50, just the same as the one submitted in evidence. These 50 valves were placed in the hose couplings, one to each of the 50 brakes, in a horizontal position, the said position being that in which the coupling hangs in practice.

I then charged the whole apparatus with 70 pounds of air pressure, the amount which is carried in practice. I then graduated the brakes and found that they all graduated in the regular order. I then released the brakes in the regular manner, by admitting air to the train-pipe, and the brakes all released. I then charged the brakes with 70 pounds air pressure again, and applied the brakes for an emergency application, and I found that the valves of patent 217,838, operated as stated in the patent,—they all opened and *quickened the action of the brakes throughout the train.* The time required to apply all the 50 brakes fully, was about eight seconds from the time the engineers' valve was opened until the pressure had equalized in the 50th brake-cylinder and auxiliary reservoir.

I then had all the valve devices of patent 217,838 removed, leaving the 50 brakes in the order that they would be in service when using the plain triple valve. I then charged the brakes with 70 pounds pressure, and applied for an emergency application. The time required to apply all the 50 brakes, without the valve device of patent 217,838, was about 30 seconds, (or nearly four times
1087 as long as when the said devices were used) from the time the engineers' valve was opened until the pressure had equalized in the 50th brake-cylinder and auxiliary reservoir. These tests demonstrated beyond doubt that the valve device of patent 217,838 does operate as set forth in that patent; that the said valve device will *not destroy* the automatic brake, and that the said valve device will *quicken* the action of the automatic brake.

Having made and tested 50 valves like that shown and described in patent 217,838 of 1879, I know that Mr. Newbury is entirely wrong in his conclusions and statements, as the facts are the valves will operate and will produce the results set forth in patent 217,838 of 1879.

The triple valves I used were of the kind known as "plain triple valves," and of a character which will not produce quick action.

248 Q. Do you regard the results you obtained, as to the quickness of action in applying on a train of 50 air brakes, as the best operative results possible to obtain from devices constructed according to patent 217,838?

A. No, I do not. I made the devices in strict accordance with the patent 217,838 in order to shut off cavil as to their being made like the devices shown and described in said patent.

If I was going to design a valve, using the patent as instructin me what the invention was, and using my judgment as to the bes form and arrangement, I am satisfied that I could make a devic which would be much quicker than the one I did make, as coul also any one who was a skilled air-brake mechanic; the paten gives any one the license to use his own judgment, as is shown fron the following quotation:

"The form or construction of the relief valve, its function an operation being substantially the same, *may be varied considerabl* in so far as it is an element in the described combination, withou any material departure from the scope of the invention." (Th italics being my own.)

1088 The train-pipe I used, and which our testing rack i equipped with, is one and one-quarter inches in diameter but if this pipe was three-quarters of an inch in diameter the valve I have made, which are in strict accordance with the patent, would be greatly quickened, and the application of the brakes quickened accordingly, as there would in the latter case only be about one third the amount of air to be discharged from the train-pipe, i comparison to the amount which was discharged in using an inch and a quarter pipe.

249 Q. As a skilled mechanic familiar with air brakes, please state what particular position the valve device of patent 217,838 should have in order to get the best operative results contemplated by the patentee?

A. I would undoubtedly place it in a position with the escape port C downward, or in the reverse position it is shown in Fig. 1. The reason I would do this is because when the brakes are not in use the valve F would keep the port C closed by the gravity of the piston D, thereby preventing any dust or dirt from getting into the valve when not in use; furthermore, it would then be in position to permit the charging of the brake by supplying the air very slowly, as the piston D and the valve parts would not have to be closed by the air pressure lifting them into position.

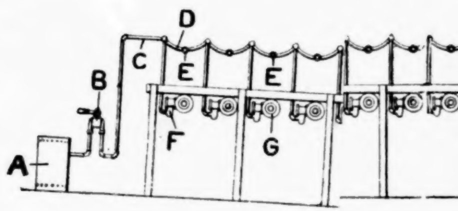
250 Q. I will now ask you to state what particular position these valves had as you used them on the test-rack?

A. They were placed in a horizontal position, that is the axes of the pistons D were horizontal, except that of one valve which had the escape port C pointing downward, and which was placed in the key of the angle cock, like "Defendants' Exhibit Westinghouse Valve Patent No. 217,838, July 22, 1879, Attached to Angle Cock." (See Fig. 17 this record.)

(Here follow diagrams marked pp. 1089 & 1090.)

793

1090



From M

Compr
enters tl
ture from
portion
Pipe.

251 Q. Please briefly describe the test-rack on which you made the tests of a valve constructed according to patent 217,838?

A. The test-rack I used was the one belonging to the
1091 Boyden Brake Company, which is erected at their shop
corner of Biddle and Chester streets, Baltimore. The rack contains 50 brakes and piping, just as used in practice; the triple valves used being of that character known as the "plain triple valve;" this rack is equipped with about 1,900 feet of inch and a quarter train-pipe, provided with hose and couplings, and all necessary adjuncts as used in practice. I will now submit a drawing showing the test-rack which was used in making the various tests with the device of patent 217,838. On this drawing (see Fig. 18), the letter A designates the storage reservoir on locomotive; B the engineers' valve; C the train-pipe; D the hose; E the devices of patent 217,838; F the plain triple valves; G the brake-cylinder; H the rack frame; I the angle cock; J the auxiliary reservoirs, and L the pipe-strainers.

Test-racks of this character are now used by the Master Car Builders' committee in testing brakes to ascertain their efficiency as to fulfilling the Master Car Builders' requirements, and therefore are the recognized form for testing brakes.

Counsel for defendants offers in evidence the drawing just referred to by the witness, marked "Defendants' Exhibit Boyden Test-rack." (Fig. 18.)

252 Q. You have stated the triple valves used on the test-rack were "plain triple valves;" please explain more particularly what triple valves they were?

A. The triple valves I used are like the one shown in the Boyden Brake Co.'s catalogue of 1891, with the bushing 9 removed, thereby giving them the capacity and functions of the plain triple valves used in 1879.

253 Q. Who assisted you in the work you did and the tests you made to determine the operativeness of the device of patent 217,838?

A. Mr. L. Gwinn, who superintended the construction of the valves and made the drawing in evidence marked "Defendants' Exhibit Copy of Working Drawing Patent No. 217,838, July 22, 1879," from the working drawing I made.

1092 254 Q. Please look at the exhibit marked "Defend Exhibit Westinghouse Valve Patent No. 217,838, Jul 1879, Attached to Angle Cock," and explain what the valve is why it is attached to an angle cock?

(Here follow diagrams maked pp. 1093 & 1094.)

A. It is a cut-off cock commonly used on each end of the t pipe of a car; the key thereof is arranged with a ported diaphr mentioned in the specification of patent 217,838 on line 18, pa and shown in Fig. 3 of the drawing, the said figure showing the valve may be attached to the train-pipe other than at the coupling.

This diaphragm in the key of the cock is so arranged that cock may be used as a cut-off cock as usual, and also to reverse position of the valve device shown in Fig. 3 of patent 217,83 which reversal to insure that the air coming from the engine pass into the device from the proper side, that is through the sage A.

As a skilled air-brake mechanic, I would place the device of pa 217,838 in a cock of this kind for practical railroad purposes, vided the device was made in exact accord with the drawing patent 217,838.

The reason for placing the valve device in the key of the a cock as I have just described is, that in case a car should be tu or placed in position in the train so that the air coming from engine would pass into the valve device through the port B¹, t the valve device could be reversed by turning the handle of angle cock diametrically opposite to the position it occupied, thereby admit the air from the engine to the valve device thro the proper passage A.

255 Q. Please state whether or not the test you made as to operativeness of the device of patent 217,838 showed any result s as Mr. Newbury, a witness for complainants, mentions on page of complainants' record, where he states:

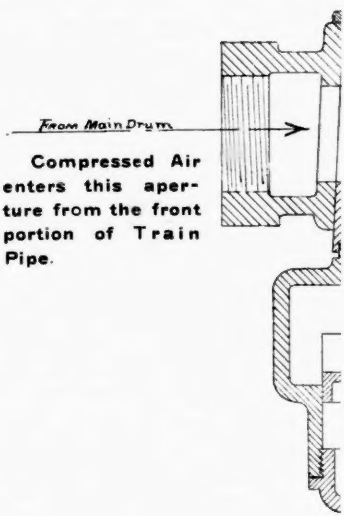
"So far as I can see the device of the patent 217,838 is not ada at all for practical operations in an automatic air-brake system in other words, an attempt to incorporate such mechan
1095 into an automatic air-brake system would simply destro and render it utterly worthless as a system."

A. In the tests I made I did not in any way see or discover the device of patent 217,838 is not adapted to the automatic br as explained in that patent, and my experiments proved con sively that it won't destroy the automatic air-brake system, if in porated with that brake system.

256 Q. Please state whether or not the tests you made to determ the operativeness of the device of patent 217,838, developed difficulty such as Mr. Newbury mentions on page 288, where states:

"The said device is shown in the drawing with its parts i certain position, and yet there are no means provided for gett

Defendants' Exhibit, Wo



Discharge

them into that position so as to charge the main air or brake pipe with pressure?"

A. In the drawing the piston D and valve F are shown in the position they occupy when the device is charged with air pressure. If there was no air pressure in the device, the valve parts would drop down from that shown in the drawing, but this is not the position the valve device would occupy in practice. In the tests I made, the axes of the valve pistons were in a horizontal position, and in every instance the valves would close when the air was admitted from the storage tank on the engine. Valves were tried in the position shown in Fig. 1, that is, with the axes of the piston in a vertical plane, and when air was admitted from the reservoir in the usual manner the piston and valves would lift and close the port C.

257 Q. Please state whether or not the tests you made to determine the operativeness of the device of patent 217,838 showed such difficulty as Mr. Newbury mentions on page 288, where he states:

"The very first attempt to apply the brakes would simply relieve the main air or train pipe of all pressure, and render the apparatus worthless as an automatic system of air brakes."

1096 A. No, they did not; when air was admitted to the train-pipe the valves all promptly closed, and the apparatus was *not* rendered worthless as an automatic system of air brakes; on the contrary, the valves performed the function as stated in patent 217,838, that is, *they quickened the action of the brakes* when the engineers' valve was manipulated in such a manner as to make them operate; therefore, Mr. Newbury's statement is untrue.

258 Q. Please state whether or not the tests you made to determine the operativeness of the device of patent 217,838 showed the difficulty Mr. Newbury mentions on page 288, where he states:

"This description shows that the normal position of piston D and the valve F is the position it dropped into below the shoulder *s*, thus leaving the port C open to the atmosphere from both sides of the piston. This construction simply renders the mechanism incapable of use, for any practical purposes in connection with an automatic air-brake system?"

A. Mr. Newbury apparently has misconstrued the quotation from the patent, because the position which he terms the "normal position" is the normal position of the piston and valve parts *when the device is acting to discharge the air from the train-pipe to quicken the action of the brake*, but it is *not* the normal position when the train-pipe is charged with air, and the brakes are released. I think Mr. Newbury is entirely wrong in his conclusions about this device in describing the valve F and the port C as being opened when the train-pipe is being charged; the tests I made disclose beyond a doubt that when air was admitted to the train-pipe the valves F closed and prevented any escape of air, nor did they in any way render the automatic air-brake system incapable of use. The tests I made demonstrated beyond doubt that the device shown in patent 217,838 would and did work as described in that patent, and that

said devices would produce useful results—*that of quickening the application of the brakes throughout the train.*

1097 259 Q. Please state whether or not the tests you made to determine the operativeness of the device of patent 217,838, showed such a difficulty as Mr. Barnes, a witness for complainants, mentions on page 629 at folio 2516:

"Such a device (217,838) so obstructs the feeding or charging process as to prevent its practical application to practical trains?"

A. I do not agree with Mr. Barnes, and the tests I made showed that the device could be used practically; the device does not obstruct the feeding or charging process stated by Mr. Barnes, as I tried it on brakes representing a 50-car train; therefore, Mr. Barnes' statement is untrue, as the brakes did charge when the device was used.

260 Q. Mr. Barnes, in the next paragraph states:

"It would be impossible to graduate the brakes in a service application, so as to make the necessary difference in the force of applying the brakes."

Please state whether the tests you made developed any difficulty of this kind.

A. No, they did not; when the engineers' valve was manipulated to graduate the brake, as it is used in practice today, the triple valves graduated the brake, that is they applied the brakes with any desired amount of pressure and the valve devices of patent 217,838 did not open, therefore, in this, Mr. Barnes was mistaken.

261 Q. Mr. Barnes, on page 630, also points out a difficulty which he states would be presented in the *application* of the brakes, and still another difficulty which he thinks would be presented in *releasing* the brakes, to which I call your attention, and ask you whether the tests you made developed any such difficulties as Mr. Barnes here refers to?

Adjourned to meet tomorrow, April 5th, 1894, at 10.30 a. m.

1098 10.30 A. M., THURSDAY, *April 5th*, 1894.

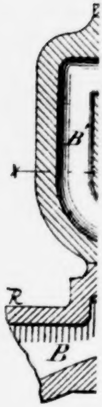
Met pursuant to adjournment.

Counsel present as before.

Deposition of G. A. BOYDEN resumed:

A. In answer to that part of your question, and Mr. Barnes' testimony referred to, pertaining to the application of the brake, I would state that Mr. Barnes is mistaken, as I found by actual test that the valve F would not unseat or open the port C when the engineers' valve was placed in the graduating position to partially apply the brakes, therefore Mr. Barnes' statement referred to is untrue. In answer to that part of your question and Mr. Barnes' testimony pertaining to the releasing of the brakes, would say that in the tests I made I found no such difficulty as to releasing the brake; on the contrary, the brakes all released in their proper order; therefore, this statement of Mr. Barnes is untrue.

Fig. 1, Westingh‹ "Defend



From Main Dr

Compressed
enters this a
ture from the f
portion of T
Pipe.

262 Q. What have you to say in regard to two relief valves v, v^1, being represented in Fig. 4 of patent 217,838, as attached on the same hose coupling?

A. As I understand the device, my opinion is that if the valves were placed as shown in Fig. 4, one of them would be inoperative to produce the result which the patent sets forth it is for; that is to say, it would destroy the charging of the brake, and I am satisfied that the valves were shown in this position by mistake, because the air would then enter one valve improperly through the aperture B^1 (see Fig. 1,) which is not the passage for the air to enter the valve device, as shown by the following quotation:

(Here follow diagrams marked pp. 1099 & 1100.)

"When compressed air enters the valve box by the *aperture* A from the front portion of the communicating pipe, it raises by its pressure the valve E, passes through the hole *d*, in the piston D, keeps the valve F closed, and passes on by the passage B^1 and aperture B to the hinder part of the pipe to charge the auxiliary reservoirs, in the usual way."

1101 From the above quotation it is obvious that the device of patent 217,838 was intended to be placed in the train-pipe in such position that the air coming from the front portions of the train or the storage tank on the locomotive must enter at aperture A and pass out at aperture B^1. This would not be the case if two valves v and v^1 were arranged as shown in Fig. 4, as one of the two would be in a wrong position to receive the air through aperture A.

263 Q. I have questioned you relative to Mr. Newbury's and Mr. Barnes' testimony touching their views of the operativeness of the devices constructed in accordance with patent 217,838 of July 22, 1879. I do not remember that either of the other witnesses for complainants made reference to this patent. As you are more or less familiar with the testimony of all of complainants' witnesses, I now ask you whether you have any recollection of either of the other witnesses commenting upon this patent?

A. I have no recollection of any other of the complainants' witnesses testifying as to patent 217,838; however, in case they did, and their testimony was of the same character as either Mr. Newbury or Mr. Barnes, I should deny the same in the manner I have the testimony of Mr. Barnes and Mr. Newbury.

264 Q. Can you produce the original working drawing which you made of the device shown in patent 217,838, and to which you referred in your answer to question 247?

A. I can; this is the drawing. I would explain that the device shown in the original working drawing is arranged on or attached to the key of the angle cock which goes on the train-pipe. The valve device can be unscrewed from this key and screwed or attached to the hose coupling, being equally well adapted to be attached to either the hose coupling or the key of the cock. I also produce a tracing of the working drawing, showing a handle to reverse the

position of the key when desired; this handle is not shown
1102 on the working drawing, although thereon there is a centre
line which indicates its position.

Counsel for defendants offers in evidence the original drawing referred to by the witness, which is marked "Defendants' Exhibit Working Drawing, Patent 217,838, on Angle Cock" (see Fig. 17); also the tracing referred to by the witness, marked "Defendants' Exhibit Tracing of Working Drawing, Patent 217,838, on Angle Cock."

(Here follows diagram marked p. 1103.)

Cross-examination *de bene esse* by J. SNOWDEN BELL, Esq., of counsel for complainants, reserving objections taken:

X 264 Q. You say that the devices which you tested to prove the operativeness of a device constructed in accordance with patent 217,838 were made "in strict accordance with the patent 217,838." In the tests which you made were they applied to and connected with the other members of an automatic brake system in strict accordance with patent 217,838?

A. They were, as I understand the patent 217,838.

265 X Q. There are two different applications of the device illustrated in patent 217,838, in one of which it is connected with the sections of a two-part hose coupling, and in the other it is applied at a point in the length of a train-pipe having a ported diaphragm; with which of these applications did your experiments accord, or did they accord with both of them?

A. They accorded with both of them—that is to say, 49 of the 50 devices were attached each to one section of a hose coupling, as shown in Fig. 1 of patent, and one of the 50 was arranged in the key of the angle cock, substantially in the manner as shown in Fig. 3—that is to say, the key of the angle cock was provided with a diaphragm O, and the device of patent 217,838 secured to the key, substantially in the manner as shown in Fig. 3.

266 X Q. Was each half section of the several hose coup-
1105 lings provided with one of these devices in accordance with
the statement of the patent that "I (the patentee) arrange at such various parts of the air conduit, but by preference at the couplings, relief valves of the kind shown in the drawings," and in accordance with Fig. 4 of the drawings of patent 217,838?

A. As I understand the quotation you refer to, it does not mean that every half section of the hose couplings of the train should be provided with these devices; therefore when I attached the devices of patent 217,838 to the couplings, I arranged one device to each two sections which make one hose coupling, and placed the device in that section which would admit the air from the main reservoir into the device through the aperture A. I did not arrange them as shown in Fig. 4, because if arranged in the manner therein shown, one of the devices would be inoperative, as stated in my testimony-in-chief.

267 X Q. Then as a matter of fact, so far as your application of the device to hose couplings was concerned, such application was *not* in accordance with the only illustration given in the drawings of the application of the device in connection with other members in an automatic brake system, to wit, that shown in Fig. 4, and differed therefrom in the particular that while said Fig. 4 shows the valve device as connected to each half section of the couplings, you only connected it to one of the half sections. This is correct, is it not?

A. So far as concerns Fig. 4, it is correct, but I consider the manner I attached the device to the couplings to be in accordance with the patent, especially so owing to the following quotation:

"The same device *may be applied at any part* of the communicating pipes, *p*, by making therein, across the bore of the pipe, a ported diaphragm O, Fig. 3."

In the arrangement of the device shown in Fig. 3, but one valve device is used, which clearly indicates but one is to be used on each car; therefore, I think I am in strict accordance with the patent in using one device to each two sections of the hose couplings.

1106 All of the last preceding answer, succeeding the word "correct," objected to as not responsive, and a volunteered argument of the witness.

268 X Q. Did you or did you not apply the devices to the couplings in accordance with Fig. 4 of the drawings of patent 217,838, and is not said Fig. 4 the only figure of said drawings in which the devices are shown in connection with a train-pipe, triple valve, auxiliary reservoir and brake-cylinder of an automatic brake system?

A. Pertaining to the first part of your question I did not apply two of the devices to each of the hose couplings as shown in Fig. 4, as I used common sense, and applied the devices to the train-pipe in such manner that they *would* work, and not in a manner that they would *not* work. As to the second part of your question, Fig. 4 is the only figure of the said drawing in which the devices are shown in connection with a train-pipe, *triple valve, auxiliary reservoir and brake-cylinder*.

269 X Q. You also say that one of the 50 valve devices of patent 217,838 which you used, was arranged substantially as shown in Fig. 3 of that patent. Does Fig. 3 show the valve device in or in connection with the key of an angle cock?

A. No, it does not, but it shows it arranged with a ported diaphragm in the pipe, and as arranged in the key of the angle cock it is there also placed in connection with a ported diaphragm.

All of the answer succeeding the word "not" objected to as not responsive, and a volunteered statement.

270 X Q. Does the description of Fig. 3 given in the specification of patent 217,838, state that the valve device is to be used in or in connection with the key of an angle cock?

A. It does not.

271 X Q. Does the specification of patent 217,838, *anywhere* state that the valve device of said patent is to be used in or connected to the key of an angle cock?

A. It does not, so far as I know.

1107 272 X Q. When applying the valve devices of patent 217,838 in accordance with what you understood and understand to be their intended application when attached to hose couplings, you were particularly careful, were you not, to attach them so that they would be on the front coupling section of a train-pipe of each car represented on the rack, that is to say, the section nearest the main air reservoir on the engine?

A. I was.

273 X Q. Do you find any indication in the drawings or instruction in the specification of patent 217,838 that in the application of valve device of said patent to an automatic brake system, it must be placed upon such coupling section, and only upon such coupling section as specified in the last question and answer?

A. The specification states as follows:

"When compressed air enters the valve box by the aperture A from the front portion of the communication pipe, it raises by its pressure the valve E, passes through the holes *d* in the piston D, keeps the valve F closed, and passes out by the passage B[1] and aperture B to the hinder portion as the pipe to charge the auxiliary reservoir, in the usual way."

From this description of the operation it is plain that the valve device must be applied to the train-pipe in such a manner that the compressed air from the storage tank or main reservoir must pass into the device by way of aperture A. From this quotation any one skilled in air brakes, in placing the device in the train-pipe, would arrange it in such a manner that it would operate as set forth in the specification.

I do not find any direct statement in the specification as set forth in your question.

274 X Q. Then as a matter of fact, and regardless of your inferences and conclusions, the specification of patent 217,838 does *not* contain any instruction or direction that the valve devices must be arranged relatively to the main air reservoir in the manner in which you arrange them; this is true, is it not?

1108 A. I do not find any passage in the specification that states that they *must* be placed as I arranged them in making the test, although the specification states:

"The form or construction of the relief valve, its function and operation being substantially retained, may be varied considerably, in so far as it is an element in the described combination, without any material departure from the scope of the invention."

This quotation gives great latitude to the skilled mechanic in the construction or form of the valve, and I think it also gives the skilled mechanic considerable scope for his judgment as to how or where the device would be arranged, so long as the described combination was maintained.

Objection to as not responsive, and an unwarranted and unasked-for statement of the witness, and counsel for complainants protests against and asks the attention of the court to the waste of time caused by the witness in formulating and enunciating arguments in response to questions of fact.

275 X Q. Could not the last preceding question have been truthfully answered by the single word "yes?"

A. It could have, but I think it my duty to the court to point out those parts of the specification wherein it states anything of a nature giving license to a skilled mechanic to use his judgment as to the construction or arrangement of the valve.

In further looking over specification I find the following (page 1, column 2, second paragraph):

"The aperture A of the valve box is seated in the lateral port opening of the *coupling R*, so as to come in the *line* of the *flow* of air through the brake-pipe, hose, and couplings." (The italics are my own.)

This quotation would also indicate that the valves are to be placed in the couplings as I placed them.

Objection and protest continued.

1109 276 X Q. Suggesting to you that your duty to the court will be better complied with if you will refrain from volunteering arguments in reply to questions of fact, and noting that you seem to object to my use of the word "must," I now ask you whether it is not true, as a matter of fact, and regardless of your inferences and conclusions, that the specification of patent 217,838, does *not* contain any instruction or direction whatever that the valve devices are to be located relatively to the main air reservoir in the manner in which you located them. This question calls for and fairly admits of a specific answer, and I will be obliged if you will give one?

A. The specification does not specify how the valve should be placed in relation to the *main air reservoir*, but it certainly does state that the aperture A must be placed so as to come in line of the flow of air through the brake-pipes leading from the main air reservoir, and I think I am justified in stating that the specification plainly implies how the aperture A of the valves are to be placed in the couplings R in reference to the flow of the air through the pipes as set forth in the last preceding quotation.

Objection and protest continued as to all of the answer succeeding the word "reservoir."

277 X Q. Could not cross-question 276 have been truthfully answered in the affirmative?

A. It could not, as I stated in my preceding answer there are instructions in the patent which direct how the valve should be located in regard to the direction in which the air passes through.

278 X Q. Then if X Q. 276 could *not* have been truthfully answered in the affirmative, please quote from patent 217,838 whatever you may choose to call an instruction or direction that the valve

devices are to be located relatively to the main air reservoir in the manner in which you located them?

A. I will quote the following (page 1, column 2, paragraphs 2 and 3):

1110 "The aperture A of the valve box is seated in the lateral port opening of the coupling R, so as to come in the line of the flow of air through the brake-pipe, hose, and couplings."

"The aperture A communicates with the port of the next *half coupling*, and the aperture B leads to the hose and brake-pipe." (The italics are my own.)

From these quotations it is perfectly plain to me, as a skilled air-brake mechanic, and I think would be to any other skilled air-brake mechanic, how to place the relative position of the aperture A in relation to the flow of the air through the train-pipe.

In the last paragraph of the two quoted, it states that the aperture A communicates with the port of the next half coupling, and this is the exact manner in which I had the aperture A of the valve device of patent 217,838 placed in making the tests referred to in my deposition-in-chief.

279 X Q. Do you desire the court to understand that you believe that the quotation made in your last preceding answer is an instruction or direction of the specification of patent 217,838, that the valve devices are to be located relatively to the main air reservoir in the manner in which you located them?

A. I certainly do.

280 X Q. Would not the aperture A "come in the line of the flow of air through the brake-pipe, hose, and couplings," just exactly as much if the valve devices had been located so that the ports B^1 were nearer the main air reservoir than the aperture A, as if they had been located in the manner in which you located them?

A. No, that is not the manner in which I would interpret the meaning of the second paragraph, column 2, page 1.

281 X Q. Would not the aperture A communicate with the port of the next half coupling just as fully if the valve devices had been located with the ports B^1 nearer the main air reservoir than
1111 the apertures A, as they would do if they had been located as you located them?

A. That is not the interpretation I would put on the paragraph. If the two paragraphs were to be interpreted in such a manner as to place the apertures, B, nearest the engine, such an interpretation and location would make the valve device inoperative, and I consider that the common-sense view as to the manner in which the paragraphs are to be interpreted, is that manner in which the valve devices will be operative.

Objected to as not responsive

282 X Q. I did not ask you anything about your "interpretation" of the specification, or of any "paragraph" in it, but *did* ask you a plain question of mechanical fact, wholly separate and apart from the specification. With this explanation I repeat cross-question 281.

A. Literally speaking, I think they would, but when taken as the devices are to be used, and in connection with the elements they are to be used with, I don't think they would, and I base my opinion on the fact that in one way the valve device 217,838 *would be operative,* whereas in the other way they would *not* be operative, and it seems obvious that *the proper way to place them* is the way in which the valve devices would be operative.

283 X Q. I did not ask you anything about the proper way to place the valve devices, and only asked you as to the communication of the aperture A with the port of the next half coupling. In order that you may put yourself clearly on record on this point, I will now ask you to state as a matter of mechanical fact for the information of the court whether the aperture A would not communicate just as fully with the port of the next half coupling if the valve devices were located with the ports B^1 nearer the reservoir than the aperture A, as they would do if they had been located as you located them?

1112 A. I have stated that they would, literally speaking, but in operation of the device with the other parts it is evident that they are to be located so that the air will pass from the main air reservoir into the device in the proper manner.

284 X Q. You say that they would "literally speaking;" would they not absolutely and unqualifiedly?

A. They would, if nothing else is to be considered in the matter; that is to say, if you just couple up two sections of coupling they would certainly be in communication if the air was admitted from either direction; but this is not the manner in which they are to be coupled when the device is to be in operation in connection with the automatic brake.

285 X Q. The aperture A would communicate just as fully, and communicate no more or no less, with the port of the next half coupling if the devices were coupled in the way in which you think they ought to be, as they would if the devices were coupled in the way in which you think they ought not to be. Is not this undoubtedly the case, as a matter of mechanical fact?

A. I have endeavored to answer the questions pertaining to the subject under discussion in a truthful manner, and in the manner that they should be answered in the light of the description of the device as set forth in the patent; they are the best answers I can give, and as I have, I think, fully answered them I think it would be useless for me to try to answer any more fully, nor can I do so.

The answer is objected to, as not in the slightest degree responsive.

286 X Q. I have not intimated a doubt of your truthfulness in your deposition, and have objected only to your substituting arguments for statements of fact when asked for. As X Q. 285 is a simple question of mechanical fact which it would be absurd to suppose that one having your mechanical qualifications is unable to answer, I shall have to repeat it, and ask you to give a categorical answer?

1113 A. I did answer it substantially in my preceding answer, in which I stated that *they would*, if the couplings were to be coupled together and nothing else considered except as to the aperture A being in communication with the port of the next half coupling.

287 X Q. Would the aperture A be any more or any less in the line of the flow of air through the brake-pipe, hose and couplings, if the devices were located relatively to the main air reservoir, in what you believe to be the proper and operative way of locating them, than if they were located in what you believe to be the improper and inoperative way of locating them?

A. I should say that in the one case they would be in the proper form of the line of the flow of air, and in the other case they would be in an improper form of the flow of air. It is true that in both positions they would be "in the line of the flow of air," but in one case the line of valve devices would be operative and in the other they would not, and I think the quotation from the patent, pertaining to the aperture A being in communication with the port of the next half coupling, undoubtedly conveys the meaning that the aperture A should be arranged as I have stated.

288 X Q. Can you not give a specific answer to X Q. 287?

A. I think I have given a specific answer when I stated that they would not be any more or less in the line of communication,—if you mean that the devices are to be just coupled together without reference to the operativeness of the devices.

289 X Q. In view of the arguments which you have made in your cross-examination, and of the manner in which you located the valve devices of patent 217,838 relatively to the main reservoir in your tests, I presume you will unhesitatingly admit that if said devices were so located in a train line that the passages B¹ would be nearest the main reservoir, so that the passage of air in the train line would be from left to right in the drawing, said devices would not only be wholly inoperative for the purpose provided in
1114 the patent, but would also be fully operative to absolutely destroy the effectiveness and operativeness of the entire brake system. Will you make this admission?

A. My understanding of the device shown in patent 217,838, is, if put in the train-pipe line with the aperture B towards the end so that the air in its passage from the main drum would first pass through the aperture B, instead of A, this air would act on the piston D so as to open the port C and prevent the brakes from being charged, and in this sense, it would destroy the operativeness of the automatic brake; but no skilled mechanic in air-brake practice would apply the devices of patent 217,838 in such a manner; on the contrary, he would apply it in a manner to make the device operative, and in such a way as to admit the air from the main reservoir, first through the aperture A as it passed to the device of the said patent. I think a man would be utterly devoid of sense to place a device in relative position to other parts in such a manner that it would be inoperative, whereas by use of common judgment he could arrange it so it would be operative, as I have done.

Answer objected to, as not responsive, and embodying a volunteered argument of the witness.

290 X Q. Will you, or will you not, unqualifiedly admit that if the devices of patent 217,838 were so located in a train line, that the passages B[1] would be nearest the main reservoir, so that the passage of air in the train line would be from left to right in the drawing, said devices would not only be wholly inoperative for the purpose provided in the patent, but would also be fully operative to absolutely destroy the effectiveness and operativeness of the entire brake system?

A. I will, and I did so admit in my preceding answer, when I stated "it would destroy the operativeness of the automatic brake."

Adjourned to meet tomorrow April 6, 1894, at 10 o'clock a. m.

FRIDAY, *April* 6, 1894.

Met pursuant to adjournment.
Present: Counsel as before.

1115 Cross-examination of Mr. G. A. BOYDEN resumed:

291 X Q. It therefore necessarily follows, does it not, that it would be mechanically impossible for the devices of patent 217,838 to be operative in an automatic air-brake system, unless each of these devices was so located in the line of train-pipe relatively to the main air reservoir, that the aperture A would be nearer the main reservoir than the passage B[1], or, in other words, the aperture A would always be nearest the front of the car?

A. My understanding of the operation of the device is that the aperture A must be located so as to receive the air from the main air reservoir on the engine, and if it is placed in the position with the aperture B towards the engine, then the device would be inoperative.

292 X Q. The statement which I made in X Q. 291 is then entirely correct, is it not?

A. I consider that it is, but in order that my answer should not be misconstrued in any way, I made the explanation set forth in my preceding answer.

293 X Q. Do you think there is any risk of being misconstrued in admitting unqualifiedly the correctness of the statement, when you consider it to be true, and have no reason to qualify it in any particular?

A. No, I do not, provided my answer is always connected with the question.

294 X Q. You will also unqualifiedly admit, will you not, that if a half coupling on the train-pipe of a car having attached one of the devices of patent 217,838 was connected to the half coupling of an adjacent car, also having one of these devices attached, as indicated in Fig. 4 of patent 217,838, said devices would not only be wholly inoperative for the purposes provided in the patent, but would be operative to absolutely destroy the effectiveness and operativeness of the entire brake system?

A. I will admit that such is the case, when the devices are
1116 placed in the positions you have referred to in your question, and I have so testified in my deposition-in-chief, in answer to question 262.

295 X Q. You will also unqualifiedly admit, will you not, that if the train-pipe of a railroad car was fitted with one of the devices of patent 217,838, it would be necessary to turn the car after each run, in order that the aperture A should always be in advance or towards the engine?

A. I will admit that such would be the case, that is to say, if there is no other means provided, the car would have to be turned around, so that the aperture A would be in position to receive the air from the main reservoir on the engine.

296 X Q. As a skilled air-brake constructor and president of the corporation defendant, is it your opinion that this or any other device which required that a car would have to be turned after every run, in order that its air-brake apparatus should be operative when moving in the opposite direction, would be a usefully operative device in an automatic air brake system, or would be accepted as such by any sane railroad man?

A. As a skilled air-brake constructor, my opinion is that this device or any other that would require the car to be turned around before the device could be used, would not be practicable at all in railroad service; and further, I don't think any sane railroad man would apply a device that would require a car to be turned before the device could be operative; and, I also consider, as a skilled air-brake constructor, I would be insane to apply such a device, or any device to a car that would not be operative, but as a skilled air-brake mechanic I would apply the device to the car in such a way that it would be operative, and I have shown one way wherein I have located the device of patent 217,838 in the key of the cut-off cock, by which the device would be made operative without reversing the position of the car.

The latter portion of the answer, commencing with the
1117 word "but" objected to as not in the slightest degree responsive, and a volunteered statement.

297 X Q. I am not asking you anything about what you or anybody else might invent to overcome the obvious practical inoperativeness of the device of patent 217,838, and my question was simply directed to that device as described and shown in that patent, and not to some other or different construction. Am I or not correct in understanding you to admit that you do not consider the device described and shown in patent 217,838 to be a usefully operative one in an automatic air-brake system, by reason of the fact that with such device the car must be turned after each run, in order to enable its brake apparatus to be operative at all when running in the opposite direction?

A. You are correct in understanding me to admit that the device shown in patent 217,838 to be operative must admit the air to the valve device through the aperture A, and if it was placed in a posi-

tion that this would not be the case, the device would be inoperative. I think, from the following quotation from the patent, that it is obvious that the inventor intended the device to be put in the train-pipe in a certain way, that is to say, with the aperture A in a position to receive the air from the storage reservoir on the locomotive. The quotation is as follows (page 1, column 2, 4th paragraph):

"When compressed air enters the valve box by the aperture A from the *front portion of the communicating pipe, &c., &c.*" (The italics are my own.)

Answer objected to as not in the least degree responsive.

297 X Q. repeated.

A. You are correct in understanding me to admit that the device as shown in the patent would be inoperative by reason of the fact that the car would have to be turned around to make the device operative, provided the car was not in the proper position to

1118 receive the air, that is to pass the air into the device through the aperture A.

298 X Q. If the car was in proper position for the device to be operative when moving in one direction, it would necessarily be in position for the device to be inoperative and destroy the effectiveness of the brake system when running in the opposite direction, would it not?

A. It would, if the air from the engine was also coming from the opposite direction.

299 X Q. I mean of course that in each direction of motion the engine was placed at the head of the train, as is usual in running a train. With this explanation, you would answer X Q. 298 unqualifiedly in the affirmative, would you not?

A. I would.

300 X Q. Coming now to this novel angle-cock device which you have presented, and which I understand you to admit is not shown in the drawing or described in the specification of patent 217,838. From your knowledge as an expert of the state of the art, was an angle cock having a ported diaphram in its key ever known or used prior to its being devised by you in the construction which you have here presented?

A. My opinion is no such cock was ever used or devised before.

301 X Q. Such a device then was not, in your opinion, known in the art at the date of the patent 217,838?

A. So far as I know, it was not.

302 X Q. Was a valve device similar to that of patent 217,838, connected to the key of an angle cock and having its aperture A communicating with a port in a diaphragm in said key as, or substantially as, in the angle-cock construction here presented by you, known in the art at the date of the patent 217,838?

A. It was not, so far as I understand.

303 X Q. Such a device or construction as is recited in the last preceding question would attain the new and useful result of over-

coming, in your opinion, the practical inoperativeness of the
1119 device described and shown in patent 217,838 due to the fact that with the device described and shown in patent 217,838 it is necessary to turn the car whenever its direction of motion is to be reversed. This is the fact, is it not?

A. It would.

304 X Q. In view of your familiarity with letters patent, and your experience as a solicitor of patents, testified to in your original deposition, please state whether or not, by reason of the novelty and utility of the angle-cock construction, recited in X Q. 302, and presented by you, said construction would involve invention, and be entitled to the protection of letters patent?

A. My opinion is that it might be.

305 X Q. It is a fact, is it not, that long prior to the institution of this suit, you yourself recognized the obvious practical inoperativeness of the device of patent 217,838, and invented and patented another appliance of that character with a view to obviating such inoperativeness; such invention being the subject of your letters patent No. 404,768, dated June 4th, 1889?

A. It is, and I also designed and used valve devices substantially like that of the patent 217,838, that is to say, a device having a port and valve mechanism to discharge the air from the train-pipe at each car, to quicken the consecutive action of the brakes which did not require a cock to reverse it, as they did not require reversal. These valves I applied to a train, which was tried on the B. & O. railroad, and worked entirely satisfactory; for this latter valve I do not remember of ever applying for a patent.

306 X Q. In making the valve devices similar to those of patent 217,838, with which you experimented, on what scale did you make them, relatively to the drawing of the patent. I mean of course the devices with which you made the test referred to in your deposition-in-chief.

A. About twice as large, that is to say, I could not follow the exact relative scale in the patent 217,838 of the device shown in Fig. 1.

1120 307 X Q. Is it not a fact that the springs in these devices which correspond with the springs *e*, of patent 217,838, are not of as great dimensions as those shown in the patent, that is to say, that they are not increased proportionately to those of the patent?

A. I cannot answer that question, because there is no means to ascertain the tension of the spring *e* in the patent.

308 X Q. And you do not therefore know what tension should be exerted by these springs to be in proper accordance with the patent, do you?

A. They should exert enough tension to just keep the valve E seated, or in its relative position as shown in Fig. 1.

309 X Q. All the tests which you made with these devices were made on the rack at your works, were they not?

A. They were.

310 X Q. How many tests did you make, and when?

A. I made various tests, commencing with one valve, then 12, then 25, then 50. It would be impossible for me to state how many times I tried them. They were made since the first of this year.

311 X Q. Were you assisted in these tests by anybody else but Mr. Gwinn?

A. No; of course the workmen were present, who would do the manual work under instructions from Mr. Gwinn or me.

312 X Q. Did you make any record of the results of these tests, and if so, can you produce them?

A. No, I made no record of the tests.

313 X Q. The record shows that in your answer to Q. 247, you originally said: "I then graduated the brakes and found that they graduated the same as though the new valve element were not employed." You afterwards amended this answer by cancelling the words "the same as though the new valve element were not employed," so that the matter as originally stated by you now reads: "I then graduated the brakes and found that they all graduated in the regular order."

1121 Did you find that they graduated "the same as though the new valve element were not employed," and if not, what difference in graduation did you observe?

A. The reason I changed the wording of the sentence you refer to was, that I did not try how the brakes graduated without the device, therefore the manner in which I first stated it was not correct. as I did not try the brakes in the graduation application without the valve devices of patent 217,838.

314 X Q. Then as a matter of fact you do not know and cannot say whether or not, when using these new valve elements of patent 217,838, the brakes graduated "the same as though the new valve element were not employed?"

A. I cannot say. What I wished to ascertain was, could the brakes be graduated without producing a quick action, and not as to the *degree of proficiency* of the graduating application.

315 X Q. Is it not the fact that in every application of the brakes which you made the valves F opened and released air from the train-pipe at points adjacent to the respective triple valves?

A. No, it is not a fact. The valves did not open when the graduation application was made, but did open when a *quick* application of the brakes was made.

316 X Q. If the valves F did not open when a graduation was made, how were you able to effect a reduction of train-pipe pressure in that part of the train-pipe in rear of the first appliance in which the valve F did not open?

A. Owing to the fact that the pistons D are about one sixty-fourth of an inch smaller in diameter than the bore of the cylinder in which the piston- D move. In making the graduation application of the brakes, the air from the rear portion of the train passes to the front portion by passing around the piston, D, or through the space between the piston and the cylinder.

317 X Q. Do you find any warrant whatever in the specification

or drawings of patent 217,838 for making the piston D one
1122 sixty-fourth of an inch smaller than the cylinder in which it works, or for making any provision whatever for leakage around said piston. If so, please indicate specifically by reference to the patent, what you consider to be your warrant for such a variation from it?

A. I find no specific statement as to the relative size of the piston in reference to the cylinder in which it works; however, my warrant for using my judgment in constructing the device, I take from the following quotation (page 2, column 1, paragraph 2.)

"The form or construction, of the relief valve, its function and operation being substantially retained, *may be varied considerably*, in so far as it is an element in the described combination, without any material departure from the scope of the invention." (The italics are my own.)

318 X Q. Is it possible that you pretend, or desire the court to understand, that you believe the quotation you have made from the patent approaches in the slightest degree to a warrant or instruction to a mechanic to make provision for leakage around the piston D, in constructing the device of patent 217,838?

A. I do, and I wish the court to understand that that is the way I interpret the specification.

319 X Q. Did you note, and can you state, the time required for effecting the application of the brakes by graduation, when using the devices of patent 217,838, modified as you have stated by the provision of a leakage space around the piston D?

A. I did not note, or take the time for graduation applications when the devices of patent 217,838 were used.

320 X Q. You are then unable to state whether or not the application of the brakes was made when graduating in the time that would be required to be usefully operative for practical purposes?

A. I am. As I before stated I was not experimenting to ascertain the *degree of efficiency* of the device, or with a view to put it in the *best* order or condition for practical purposes; I merely
1123 wished to ascertain if the device would quicken the action of the brakes, graduate and release them, without destroying either of the operations.

321 X Q. Now, as to release, which, as you will probably recognize, is a matter of some little importance, as to useful operativeness in practical service. You say, "I then released the brakes in the regular manner, by admitting air to the train-pipe, and the brakes all released."

Did you note, and can you state, how long it took them to release?

A. I did not time the release, and therefore cannot state the exact time, although the brakes released in about the same manner that the brakes usually release when the rack is equipped with our regular quick-action valve.

322 X Q. I am asking you only as to the *time* of release, and nothing as to the manner. Is it not the fact that the time of release was greatly longer than under ordinary conditions, and much too long to comply with the requirements of practical service?

A. No, it was not a great deal longer, if any, nor was it of such a duration of time that it would be impracticable in operation in service.

323 X Q. Did you time the release?

A. No, I did not.

324 X Q. Now as to charging. You say, "I then charged the brakes with 70 pounds air pressure." How long did it take you to charge the train?

A. I did not time it.

325 X Q. Did it not take, as far as you observed, a materially longer time to charge the train with 70 pounds of air pressure than is the case in usual and correct practice?

A. No, it didn't take a *materially* longer time, but my recollection is that it was somewhat longer, although I didn't take any time.

326 X Q. You say, referring to the device of patent 217,838, that it "does not obstruct the feeding or charging process." Is it
1124 not obvious on inspection to any mechanic that the presence in a train line of a series of spring-pressed valves, each of which must be unseated, in feeding or charging, necessarily must obstruct that process?

A. I should say it was if the springs are of such a tension that it required a considerable preponderance of pressure to overcome the spring, but in the device shown in patent 217,838, I can see no reason or advantage in having a spring of any greater tension than is just sufficient to move the valve to its seat. My opinion, however, is that the device would work equally well if no spring was employed at all, simply because when the air pressure moves from aperture B to A, that pressure would close the valve E.

All of the answer succeeding the word "was" objected to as not responsive.

327 X Q. Wholly regardless of the *degree* of tension of the springs, is it not self-evident that the presence in the train line of a *series* of valves which must be unseated in feeding or charging, must necessarily affect that operation?

A. No.

328 X Q. Then am I to understand that you are under the impression that the feeding and charging of the train line could be performed just as well and just as quickly when provided with a series of the appliances of patent 217,838, as could be done in the ordinary train line?

A. My opinion is it would take some longer time, just to what degree I can't say, but the delay would not be sufficient to interfere with the practical operation, or charging of the brakes.

329 X Q. That delay, however the extent of which you do not know, would be due altogether, would it not, to the obstruction of the train line by the devices of patent 217,838. If you shall say that it would not be, please state what you think it would be due to.

A. I have stated the charging would be somewhat slower, but if I was going to make the devices, using such judgment as the
1125 patent licenses me to use, I should make a device in accord-

ance with that patent and would charge the train and brakes for all practical purposes just as quickly as through the devices were not used in the train-pipe. The delay, however, which I have referred to, in some of my preceding answers, would be caused by the devices as shown in patent 217,838.

330 X Q. Could not the last question have been truthfully answered by the single word "yes," without the slightest qualification whatever?

A. It could have, but I thought it was proper for me to express my opinion on the matter under discussion.

331 X Q. Did the opinion which you expressed, in the slightest degree qualify a direct affirmative answer to the question?

A. It does, to the extent that I was making devices under the guidance of the patent, and using my judgment, as a skilled air-brake mechanic.

332 X Q. Were you asked anything about the probable results of your efforts to accomplish the feat of making the passage of air through an obstructed pipe as easy and rapid as through an unobstructed one?

A. No, I was not asked for my opinion.

333 X Q. You say that you charged the brakes with 70 pounds pressure, and "applied for an emergency application." How did you manage to apply for an emergency application, if, as you state, the triple valves which you used were "plain triple valves," and "of a character which will not produce quick action"?

A. I threw the handle of the engineers' valve to that position in which the train-pipe air would be discharged fully, and let it remain in that position until all the air was discharged from the said train-pipe.

334 X Q. I presume you mean by that that you manipulated the engineers' valve in such a way that a quick-action or emergency application would have been effected if you had been using quick-action triple valves. Am I right?

A. In a sense, you are, that is to say, that you could place the engineers' valve in the emergency-application position, and
1126 leave it remain open; but in producing a "quick action" with the quick-action valves as now generally used in practice, the engineers' valve is manipulated sometimes in such a manner that the train-pipe is first discharged of about 20 to 30 pounds pressure, and then the engineers' valve is blanked. Of these two ways, I used the first, that is to say, I placed the engineers' valve in full open position, and let it remain there until the pressure had equalized in the 50th brake-cylinder and auxiliary reservoir.

335 X Q. You say I am right in *a* sense. Am I not right in *every* sense, and if not, in what sense am I wrong?

A. No, you are not right, as I understand the matter. I have stated that there are two ways of manipulating the engineers' valve in producing quick action. You asked me in question 333, "How did you manage to apply for an emergency application." I replied by stating that I threw the handle of the engineers' valve in a certain position. You then asked me in question 334 if I put it in that

position for a quick-action or emergency application, when the quick-action triple valves were used. I then stated in a sense you are right, meaning by that, that I did place the engineers' valve in one of the positions, and held it there, that is used in producing emergency application of the quick-acting valves now in use. That is what I meant by "in a sense."

336 X Q. X Q. 334 did not say a word about "the position" of the engineers' valve, and simply asked you whether or not "you manipulated the engineers' valve in such a way that a quick-action or emergency application would have been effected if you had been using quick-action triple valves." Did you or did you not do so?

A. I did so.

337 X Q. Then whether there are two, or two hundred, or two thousand ways of manipulating the engineers' valve to effect a quick-action or emergency application, I was right in *every* sense, was I not, in the statement made in X Q. 334?

1127 A. You were. Had I understood your question at first as fully as I did when you repeated it, I would have made the answer that I did when you repeated it.

338 X Q. After you made, in your test, an application of the brakes in which the valves F opened the release port C, the pistons D dropped below the shoulders *s*, and there was then an open communication between the train-pipe and the atmosphere through each of the appliances of patent 217,838. This is a fact, is it not?

A. As I understand your question, there was.

339 X Q. How was it that when you attempted to recharge the train line, the air did not escape therefrom through these open communications to the atmosphere?

A. Because when the air was again admitted to the train-pipe from the storage reservoir, it passed into the aperture A and acted on the piston D, thereby moving the piston and valve F to the closed position, as shown in Figs. 1 and 3.

340 X Q. Did not the first portion of the air which was admitted to each of the appliances when recharging, escape through the then open communication, before the piston closed the valve?

A. I did not observe that any escaped. All the valves promptly closed throughout the train.

341 X Q. Are you prepared to say, and do you say, that the first portion of the air admitted to each of the appliances in recharging did not escape through the then open port C before the piston closed the valve F on that port?

A. I am prepared to say that if there was any escape, it was of such a small quantity, that it was not appreciable, as in making all the tests, the valves or devices of patent 217,838, closed so promptly that all the brakes were released.

342 X Q. You do not, however, know how much air was wasted in this way; how much delay in charging, and how much delay in releasing the brakes was involved. This is a fact, is it not?

1128 A. If there was any waste of air, or delay in charging and releasing the brakes, it was of such a nature that it was not

perceptible. I did not experiment to ascertain just what these conditions were, if the conditions existed.

Answer objected to, as not responsive.

X Q. 342 repeated, and a categorical answer requested.

A. I do not, but if there was such waste and delay as you mention, they were of such a nature that it didn't interfere with the practical operation.

All of the answer succeeding the word "not" objected to, as not responsive, and further as incompetent, in view of the witness' admissions that he did not take note of the quantity of air wasted, or of the time required for charging and releasing.

343 X Q. Did the tests which you made with the device of patent 217,838, demonstrate that said device was practically operative in anywise for admitting air in the application of the brake directly from the main air pipe to the brake-cylinder?

A. They did not.

344 X Q. Did the tests which you made with the device of patent 217,838, demonstrate that said device was in anywise practically operative to admit air from the auxiliary reservoir to the brake-cylinder by preliminary traverse of the triple-valve piston, and to admit air directly from the main air pipe to the brake-cylinder by a further traverse of the triple-valve piston?

A. They did not.

345 X Q. Did the tests which you made with the device of patent 217,838, demonstrate that said device was practically operative to a degree sufficient to warrant you or any other capable air-brake constructor in advising its adoption in practical railway service?

A. The tests demonstrated that the device would quicken the action of the brakes; and they demonstrated to my mind, as I think they would to any one who is skilled in air brakes, that the device of patent 217,838 could be so arranged and modified to suit
1129 the automatic air brake as to make it just as efficient a brake as those now in general use, and one that could be recommended to railroad officials for practical use.

Answer objected to as not responsive.

346 X Q. X Q. 345 repeated.

A. The results produced by the devices of patent 217,838, *as I tried them*, were not of an efficiency that would justify me in recommending the use of the devices to railroad officials.

347 X Q. Did the tests which you made with the device of patent 217,838 demonstrate that said device was practically operative to such a degree as to lead you to believe that it would be acceptable to, and accepted by, any competent railroad official, for use in practical railroad air-brake service?

A. The tests I made with the device of patent 217,838 demonstrates that the device, as I made them, was not practically operative to be used in service; but they demonstrated that the device of patent 217,838 could be so modified that it would practically be oper-

ative in railroad service. As to being able to get railroad officials to adopt it, that is something I cannot say, as I might be able, then again I might not.

348 X Q. I am not asking you anything about what possibly might be the case if the device was modified, as it is quite evident that in the light of subsequent invention, it might be modified so materially as possibly to be converted into something that was practically operative. I am, however, asking you as an expert, whether in your opinion the tests made by you demonstrated that the device as it is, was practically operative to such a degree as would lead you to believe that a competent railroad official would accept it for practical service on *its* road. Please let me have your opinion on this point.

A. My opinion is that the device, *as I used it*, would not be acceptable to railroad officials, for practical use.

Counsel for complainants now closes the cross-examination of the witness, and asks of counsel for defendants upon the record whether or not he will consent, first, that a repetition of the
1130 experiments recited by the witness in his deposition-in-chief shall be made by him in the presence of complainants' counsel and experts, at such early day as may be suitable to the engagements of both counsel; and, second, whether he will furnish to complainants' counsel the 50 valve devices of patent 217,838, with which the witness' tests were made, in order that the complainants may make tests thereof upon their own testing rack.

Counsel for defendants states that before making answer to the request which counsel for complainants has made, he desires time to consult with the principal counsel in the case, and states that he will communicate with the counsel who is out of the city, and will make a definite answer as soon as he shall be advised by the principal counsel, which will probably be by the 11th day of April.

Counsel for complainants will be obliged if defendants' counsel will advise him by wire of his decision in the matter, in order that if a repetition of the experiments is to be made, it may be done as early as practicable, and in view of the engagements of complainants' counsel, it is doubtful whether he would be able to attend for the purpose except on some day in the latter part of next week.

Counsel for defendants replies that he will wire counsel for complainants his answer within the time already named.

GEORGE A. BOYDEN.

LEVEN J. GWINN, a witness produced on behalf of the defendants, having been duly sworn, deposes and says, in answers to interrogatories propounded to him by Charles B. Mann, Esq., of counsel for defendants, as follows, to wit:

1133 1 Q. What is your name, age, residence and occupation?

A. Leven J. Gwinn; 31 years old; Baltimore; machinist and mechanical draftsman.

2 Q. Please look at the drawing of patent granted to George Westinghouse, Jr., July 22, 1879, No. 217,838, and state what part you

took in making working drawings for the construction of the device shown therein?

A. I made all the detail working drawings and sketches necessary for constructing the devices shown therein from the original drawing made by George A. Boyden, which he made from drawings of patent No. 217,838, in my presence. I also made two drawings from same original drawing to be used as exhibits in taking this testimony; one being a device shown in patent No. 217,838, and the other being the same device attached to the key of an angle cock. I identify this drawing, marked "Defendants' Exhibit Copy of Working Drawing, Patent 217,838, July 22, 1879," as the drawing I made from the original drawing made by Mr. Boyden. Here is another drawing I identify, marked "Defendants' Exhibit Tracing of Working Drawing, Patent 217,838, on Angle Cock."

3 Q. Please state whether or not the drawing marked "Defendants' Exhibit Copy of Working Drawing, Patent No. 217,838, July 22, 1879," (Fig. 16,) shows the same construction as that of Fig. 1 in the drawing of patent 217,838? (See Fig. 15.)

(Here follows diagram marked p. 1132.)

A. It does show the same construction.

4 Q. Please state what steps were taken by Mr. Boyden's orders to make devices like that shown in patent No. 217,838?

A. I was ordered to have patterns made, and to get castings made off of same, and to fit up one or two of the devices or relief valves, shown in Westinghouse patent 217,838, which I did. I was then ordered to make a dozen more, and finally 50 of them were made.

5 Q. State whether or not the devices which you referred to as made in accordance with patent 217,838, were tested?

1134 A. They were tested. They were tested on a test-rack in the Boyden Brake Company's shops. This rack has 50 complete automatic air brakes on it, consisting of 50 auxiliary reservoirs, brake-cylinders and plain triple valves, with engineers' valve, gauges, and about 1,900 feet of inch and a quarter train-pipe, with angle cocks, str-ight cut-out cocks, hose and couplings, and an air pump or compressor, and other necessaries pertaining to a test-rack for making air-brake tests. 49 of the devices made from patent 217,838 were each attached to one half section of hose couplings throughout the train, and one was attached to the key of an angle cock in a vertical position with the relief or discharge port C, downwards.

6 Q. Briefly describe the tests that were made on that test-rack, to ascertain the operativeness of the devices constructed according to patent 217,838?

A. We proceeded to test, by placing the engineers' valve in full release position; we then started the air compressor, charging all the auxiliary reservoirs and train pipe to 70 pounds pressure; then by placing the engineers' valve handle in the graduating position and gradually reducing the train-pipe pressure, putting about 20 pounds of air in the brake-cylinder. The 50 relief valves or devices

did not discharge any air during this application of the brake. We then placed the engineers' valve handle on the lap or blank position, the air holding the brakes in the applied position. We then placed the engineers' valve handle in full release position to release the brakes, and recharge the auxiliary reservoirs and train-pipe to 70 pounds pressure. We then placed the engineers' valve handle in a quick action or full emergency position, suddenly discharging the train-pipe air at the engineers' valve, thereby causing the brakes to take a quick action and equalizing in the 50th brake-cylinder and auxiliary reservoir at 45 pounds. We then released the brakes by placing the engineers' valve in full release position, and recharging the auxiliary reservoirs and train-pipe to 70 pounds pressure, and uncoupling the hose couplings in train-pipe at
1135 the 25th brake, representing a train breaking in two; the train-pipe air being suddenly reduced at that point, causing the relief valves on the twenty-five rear couplings to uncover discharge ports C to the atmosphere and discharging a portion of the air therefrom, causing the rear 25 brakes to take a quick action, and the 25 brakes nearest the engine to take a full service application. The 50th brake-cylinder and auxiliary reservoir and the first, equalizing at 45 pounds. We then took off all the relief valves and replaced the spiders and caps to hose couplings, thereby making them as usual hose couplings, and recharged the auxiliary reservoirs and train-pipe to 70 pounds pressure. We then placed the engineers' valve in the quick-action position, or full emergency position, and suddenly discharging the train-pipe air, the brakes applied, but not with a quick action, they equalized at 45 pounds in the 50th brake-cylinder and auxiliary reservoir.

7 Q. Please state what you mean by the expressing "causing the brakes to take a quick action."

A. I mean that discharging the train-pipe air suddenly, caused the brakes to move out or apply quickly.

8 Q. Please state, as near as you can, the time that was required in applying the brakes when the device of patent 217,838 was used, and the time required in applying the brakes when that device was not used.

A. In applying the brakes when device 217,838 was used, the quickest time, from the movement of the engineers' valve handle until the 50th brake-cylinder and auxiliary reservoir equalized, was eight seconds; when applying the brakes while devices 217,838 were not used, the quickest time from the movement of the engineers' valve handle until the 50th brake-cylinder and auxiliary reservoir equalized, was 30 seconds.

9 Q. State what particular position the valve devices of patent 217,838 had in making the tests which you have described.

A. 49 of them were applied in a horizontal position, and one was applied in a vertical position, with the relief or discharge port C downward.

1136 10 Q. As you are familiar with air brakes, please state what particular position the valve device of patent 217,838

should have, in your opinion, in order to get the best operative results.

Objected to, as incompetent, it not having been shown that the witness is familiar with air brakes, or capable of forming an opinion intelligently as to the best operative results of the devices connected therewith.

A. I have been employed with the Boyden Air Brake Company for the past five years, as a machinist, and mechanical draftsman; am at present holding a position with the said company as general foreman. I have been sent by the Boyden Brake Company several times to superintend the application of air brakes to freight cars and to locomotives on railroads at points distant from Baltimore; I have also been sent by them to look after complaints of brakes not working right, or being out of order, from various causes, all of which I have replaced in working order.

In answer to your question, my opinion is, that the device should be applied in a vertical position, with relief port C downward, to prevent dirt and foreign substances getting therein.

Adjourned to Saturday, April 7, 1894, at 10 a. m.

SATURDAY, *April* 7, 1894.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination of Mr. L. J. GWINN resumed:

A. (Resuming:) This position also ensures that the relief port C will be closed by the gravity of piston D and valve F when starting to charge the train-pipe with air.

11 Q. Please state whether or not the tests Mr. Boyden and you made on the test-rack with devices constructed according to patent 217,838, developed any difficulty that suggested said devices were inoperative.

1137 A. No, there was nothing occurred during the tests that suggested to me that the devices were inoperative; to the contrary, they all operated as I expected them to operate, and as I constructed them to operate.

Cross-examination by J. SNOWDEN BELL, Esq., counsel for complainants:

12 X Q. Did you personally do the turning, boring and other machine work necessary to fit up the 50 devices of patent 217,838, with which the tests were made, or was this done by a machinist working under your orders as general foreman of the Boyden Brake Company?

A. It was done under my orders, as foreman of the Boyden Brake Company, by a machinist and workman.

13 X Q. I notice that the original working drawing which you say was made by Mr. Boyden, marked "Defendants' Exhibit Working Drawing, Patent 217,838, on Angle Cock," shows the piston to

be about one thirty-second of an inch smaller than the bore of the casing in which it fits, so as to leave a space of about one sixty-fourth of an inch all around the piston between its periphery and the bore of the casing in which it fits; this is a fact, is it not?

A. The drawing does show the piston about one thirty-second smaller than the bore.

14 X Q. Were the 50 devices of patent 217,838, with which the tests were made, fitted up in accordance with the working drawing in the particulars stated in the last question; that is to say, with their pistons (the pistons D of the patent) about one thirty-second of an inch smaller than the bore of the casings in which they were?

A. The devices were fitted up with the pistons about a sixty-fourth smaller than the bore of the casing in which they worked.

15 X Q. Why did you not follow the original drawings and make them about one thirty-second of an inch smaller as shown in said drawing?

1138 A. Because in putting the line in the drawing, there was no particular measurement made, the lines were put in by the eye, intending them to be about one sixty-fourth smaller than the bore.

So much of the answer as relates to what was the intention in making the drawing objected to as incompetent, for the reason that the witness has testified that the drawing was made not by himself but by Mr. Boyden.

16 X Q. Did Mr. Boyden instruct you to make the pistons smaller than the bores of the casings in which they worked; and if so, how much smaller did he tell you to make them?

A. Mr. Boyden did instruct me to make the pistons one sixty-fourth of an inch smaller than the bore of the casing.

17 X Q. You say that Mr. Boyden made this original drawing in your presence from the drawings of patent 217,838. Do the drawings of patent 217,838 show the piston D as being smaller than the bore of the casing in which it fits; that is to say, do they show any space whatever between the periphery of the piston and the bore of the casing?

Counsel for defendants objects to the question as being wholly immaterial; the drawing in the patent not being a working drawing.

To which complainants' counsel replies that the question is intended to test the accuracy of the statement that the original drawing in evidence was made from the drawing in the patent.

A. The drawing of patent 217,838 does not show any space between piston and bore of casing.

18 X Q. Does the drawing of patent 217,838 show an angle cock, or show a valve device connected to an angle cock?

A. It does not.

19 X Q. Does the specification of patent 217,838 instruct that the

BLEED. THROUGH POOR COPY

1139 piston D is to be made smaller than the bore of the casing in which it works, or that any space is to be provided for the passage of air around said piston?

A. I cannot say, as I have not carefully read the specification.

20 X Q. In making the drawing "Defendants' Exhibit Copy of Working Drawing, Patent 217,838, July 22, 1879," and the tracing "Defendants' Exhibit Tracing of Working Drawing, Patent 217,838, on Angle Cock," why did you not make said drawing and tracing correspond with the original drawing, that is to say, by showing on them the piston as about one thirty-second of an inch smaller than the bore of the casing in which it works, as is shown in said original drawing?

A. If the tracing does not show the piston smaller, it was purely a mistake on my part, as I made the tracing hurriedly, and leaving out the lines showing piston smaller than bore by mistake, or oversight.

21 X Q. It is a fact, is it not, that the tracing *does not* show the piston as about one thirty-second of an inch smaller than the bore as the original working drawing does, but shows it as closely fitting in the bore, just as the patent drawings do?

A. It is a fact that the piston shown in tracing does not fit loose in bore of casing.

22 X Q. You mean then to answer the last preceding question specifically in the affirmative, and could have truthfully answered that question by the word "yes"? This is a fact is it not?

A. I could have answered the last preceding question with the single word "yes."

23 X Q. And it is also true, is it not, that the drawing "Defendants' Exhibit Working Drawing, Patent No. 217,838, July 22, 1879," does not correspond with the original drawing in showing the piston as about one thirty-second of an inch smaller than the bore of the casing in which it works, but shows it as closely fitting in the bore just as the patent drawings show it?

A. Yes, it does.

1140 24 X Q. Was this difference between the drawing last referred to and the original working drawing also a matter of oversight on your part?

A. It was.

24 X Q. Were you instructed for what reason you were to make the pistons of the devices which you were fitting up one sixty-fourth of an inch smaller than the bore of the casings in which they were to work?

A. I was not.

26 X Q. From your experience as a mechanic skilled in air brakes, please state whether or not it would be possible to make a graduated application of the brakes when using the device of patent 217,838, if the pistons D are made to fit the bore of the casing in which they work as shown in the drawings of the patent?

A. My opinion is that you could make a graduated application with the piston D fitting closely to the casing.

27 X Q. Did you ever try to do so?

A. I have tried to do so.

28 X Q. Did you succeed?

A. I did.

29 X Q. How long did it take to make the application under such circumstances?

A. That I could not say, as I did not time the application.

30 X Q. In the tests made by Mr. Boyden with these devices, at which you assisted, did you make any note of the time required for charging, the time required for releasing, or the time required for making a graduated application?

A. I did not.

31 X Q. And I presume that you are unable to state the time required for either of the operations specified in the last preceding question?

A. I am unable to state the time.

32 X Q. As a mechanic skilled in air brakes, please state whether or not you consider the device of patent 217,838 to be practi-
1141 cally operative to such an extent that it would be acceptable to, and accepted by, any competent railroad man for regular service on his road?

A. I do.

33 X Q. In this particular then, you do not agree with Mr. Boyden, do you, as he states that in his opinion it would not be acceptable to railroad officials for practical use?

A. I don't agree with Mr. Boyden in that respect.

LEVEN J. GWINN.

Adjourned *sine die.*

United States Circuit Court for the District of Maryland.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY
vs.
BOYDEN POWER BRAKE CO.; GEORGE A. BOYDEN, President; CHARLES B. MANN, Secretary, and WILLIAM WHITRIDGE, Treasurer.
} In Equity. No. 321.

Notice to Counsel for Complainants.

Counsel for defendants, referring to the request made on the record by counsel for complainants, Friday, April 6th, 1894, asking for a repetition in the presence of complainants' experts and their counsel, of the experiments testified to by Mr. Boyden, and which were made by him and Mr. Gwinn for the purpose of ascer-
1142 taining the operativeness of devices constructed in accordance with U. S. patent No. 217,838, dated July 22nd, 1879, granted George Westinghouse, Jr., now desires to make further response to that request as follows:

Defendants are ready and willing to exhibit the said experiments and tests on Thursday, April 12th, 1894, at 2 p. m. in the presence of counsel and two expert witnesses on behalf of complainants,

under such conditions as will be reasonable for both parties, with the object in view of guarding against possible misrepresentation thereafter as to what were the actual results shown by the said experiments and tests. And counsel for defendants proposes the following conditions, to wit:

First, that the defendants be represented at the tests by one counsel and two witnesses and complainants be represented by a like number.

Second, that while making the tests and experiments notes or written memoranda shall be kept of the tests and experiments as made and of the results of the same.

Third, that from said notes or memoranda the persons present as witnesses for defendants, shall prepare a written statement briefly describing and setting forth the tests and experiments and the results of each test, and that each witness present on behalf of defendants may be called the next morning, Friday, April 13, 1894, at 10.30 o'clock to testify and subscribe to this statement under oath, subject, of course, to the cross-examination of counsel for complainants.

Respectfully,

CHAS. B. MANN,
For Defendants.

Baltimore, Maryland, April 10th, 1894.

BALTIMORE, MD., *April* 13, 1894.

1143 Testimony on behalf of defendants, taken in accordance with the foregoing notice, at the office, No. 544 Equitable building.

Present: Charles B. Mann, Esq., of counsel for defendants; J. Snowden Bell, Esq., of counsel for complainants.

GEORGE A. BOYDEN, being recalled, deposes and says, in answer to interrogatories propounded to him by Charles B. Mann, Esq., of counsel for defendants, as follows, to wit:

349 Q. Are you the same George A. Boyden who has heretofore testified in this cause?

A. I am.

350 Q. Please give an account of the repetition of the experiments and tests with valve devices constructed according to patent 217,838, made yesterday at the shops of the Boyden Brake Company, which experiments and tests you and Mr. Gwinn have heretofore testified to; and also state the occurrences that took place on that occasion.

A. Yesterday at the shop of the Boyden Brake Company, I repeated the tests referred to in your question, in the presence of Messrs. J. Snowden Bell, H. H. Westinghouse and D. L. Barnes, representing the complainants, and Mr. Chas. B. Mann, L. Gwinn and myself, representing the defendants.

The tests made and the results were as follows:

Fifty automatic air brakes having the capacity of automatic air brakes as used in the year 1879, were mounted on the test-rack heretofore described, with relief valves constructed in accordance

with U. S. patent, No. 217,838, dated July 22, 1879, granted George Westinghouse, Jr.

First. The apparatus was charged with about 70 pounds of air pressure, all the auxiliary reservoirs charging up.

Second. The engineers' valve handle was placed in the "graduating position" and all the brakes were gradually applied, the degree of application being varied as desired.

1144 Third. The engineers' valve was then placed in position to release the brakes, and all the brakes released.

Fourth. The brakes were then again charged with about 70 pounds air pressure.

Fifth. The engineers' valve was then placed in position for "emergency" applications, and all the brakes quickly applied; the time required from the movement of the engineers' valve until the pressure equalized in the fiftieth brake-cylinder and auxiliary reservoir, was about ten and one-half seconds.

Sixth. The engineers' valve was then moved to release the brakes; all the brakes released but one. The occasional non-release of a brake in a train of 50 cars is not an unusual thing with the best brakes in use today. The failure of this one brake out of the fifty to release, was not attributable to the device of patent, No. 217,838. The apparatus was then recharged with about 70 pounds air pressure.

Seventh. The twenty-fifth hose coupling was then uncoupled to represent an automatic action of the brakes as occurs in the practical use of brakes when a train accidentally separates or breaks into two sections. In this test the twenty-five brakes on the rear end of the test-rack applied *quickly*. The twenty-five brakes on the forward end of the test-rack applied more slowly, which would be the preferable manner in practice, because the forward part of the train would move far enough ahead to prevent the rear part from colliding with it, as the rear section would be stopped in a shorter distance than the front section would be.

Eighth. We now removed all valves of patent, No. 217,838, and restored the caps of the hose coupling; the test-rack being now equipped with automatic brakes having the capacity of air brakes as in 1879, using "plain triple valves."

Ninth. The brakes were then recharged with air pressure.

Tenth. The engineers' valve was then again placed in position for an "emergency" application. This test was the same as 1145 in the fifth test, except that none of the relief valves of patent, No. 217,838, were used. In this test all the brakes applied, *but much slower* than they did in the said fifth test; the time now required from the movement of the engineers' valve until the pressure equalized in the fiftieth brake-cylinder and auxiliary reservoir was about 31 seconds, or twenty and a half seconds slower than when using the valve device of patent 217,838.

The foregoing comprised the tests made on the test-rack relative to the operativeness of the device of patent, No. 217,838, which Mr. Gwinn and I mentioned in our previous testimony.

The main points or substance of this account which I have now

given of these repeated tests, were gone over and stated aloud in the presence and hearing of all the persons in attendance while these tests were being made, including the three representatives of the complainants in this suit, and they and we all agreed that said main points of the tests were fairly and correctly stated.

After these tests had been made, the representatives of the complainants made inquiry of the representatives of the defendants asking in effect if we would make some further experiments, and suggesting that they wanted to put the engineers' valve in the "running position" to see how the brakes would release in that position. As this "running position" is one that is not used in practice to release the brakes, I declined to make this test; because first, the proposed test would be more severe than the standard brakes of today are subjected to in practice when releasing; and, second, the valve devices of patent 217,838, which I had constructed, were *not* made for the purpose of comparing *their* action with that of the standard brakes of 1894, *fifteen years after the invention of patent* 217,838. These valve devices were made simply to demonstrate if they would work as set forth in the specification thereof, which they do, and having demonstrated this, it would not be consistent to make the test solicited by complainants' counsel, as neither
1146 the valve device of patent No. 217,838, nor any other brake-valve, were intended to release under the conditions named in the solicited test.

The complainants' counsel also requested that we should have new pistons made which would tightly fit in the cylinders of the devices of patent 217,838. This was also declined, because, I know the devices are made in accordance with patent 217,838, for the simple reason that they work as the specification of that patent states they should work, and they produce the result which the devices of patent 217,838, of 1879, were invented to produce.

Cross-examination by J. SNOWDEN BELL, Esq., of counsel for complainants:

351 X Q. When you say that the 50 automatic air brakes used in the test of yesterday were provided with "relief valves constructed in accordance with U. S. patent No. 217,838, dated July 22, 1879, granted to George Westinghouse, Jr.," you refer, do you not, to the appliances made under your direction, and referred to in the testimony given last week by yourself and Mr. Gwynn, in which appliances the pistons were made one sixty-fourth of an inch less in diameter than the casing in which they worked?

A. I do.

352 X Q. When you say, referring to yesterday's proceedings, that "they (the three representatives of the complainants) and we all agreed that said main points of the tests were fairly and correctly stated," you refer, do you not, to the verbal statements made in the course of these demonstrations?

A. I refer to the conversation we had after the tests. Mr. H. H. Westinghouse suggested that before separating he thought it was

well for us to have an understanding between us all if we agreed on the results, of the tests; and this is what I referred to in my answer, pertaining to our mutual understanding.

353 X Q. You say that at yesterday's tests, the complainants' counsel requested that you would have new pistons made, etc.
1147 Are you not in error as to this statement, and is it not the fact that what complainants' counsel requested was that you would make a test with devices having their pistons fitting the cylinders without the slackness of a difference of one sixty-fourth of an inch in diameter between the pistons and the cylinders which exists in the devices with which the tests were made?

A. I did not make a note of the exact phraseology used by the complainants' counsel, but my understanding at the time was that he wished a test made with pistons fitting the cylinders more tightly than those that were used; as we did not have such pistons, I could only make such a test by first having new pistons made, which would have taken considerable time, and was one of the reasons why I declined.

Counsel for complainants calls the attention of counsel for defendants, that his request made at our last session, as yet remains unanswered, such request being that complainants' counsel should be furnished with the 50 valve devices of patent 217,838, with which Mr. Boyden's tests were made in order that the complainants' may make test thereof upon their own testing rack. This request was made partly for the purpose of enabling the complainants to verify the correctness of the tests heretofore made, and partly to enable the court to be more fully informed as to the question of the operativeness in practice of the devices, without involving the delay which will be caused if complainants are obliged to duplicate these devices for their own experiments. A reply on the record to this request is now asked for.

Counsel for defendants replies that defendants have fully exhibited the devices and repeated the tests which they previously made, in the presence of counsel for complainants and two expert witnesses, and having done this, counsel does not perceive that defendants are under any obligation to furnish complainants with their devices, and accordingly declines.

G. A. BOYDEN.

1148 LEVEN J. GWINN, being recalled, deposes and says, in answer to interrogatories propounded to him by Charles B. Mann, Esq., of counsel for defendants, as follows:

34 Q. Are you the same Leven J. Gwinn who has heretofore testified in this cause?

A. I am.

35 Q. Please state whether you were present yesterday at the shops of the Boyden Brake Company, while the experiments and tests were made, to which Mr. Boyden has testified this morning in answer to question 350, and if yea, state whether you have read the

BLEED THROUGH POOR COPY

statement made by Mr. Boyden, in answer to that question, and whether the same is true and correct.

A. I have read carefully the statement made by Mr. Boyden this morning in answer to question 350, in which he gives an account of the repetition of tests he made yesterday in the presence of the three representatives of the Westinghouse Air-brake Company. I was present during those tests, and assisted in making them. Mr. Boyden's statement is true, and an accurate account of what was done on that occasion.

Cross-examination by J. SNOWDEN BELL, Esq., of counsel for complainants:

36 Q. Do you agree substantially with Mr. Boyden in the answers he gave this morning to my cross-questions?

A. I do agree with Mr. Boyden in regard to his answer to cross-question 351; as to the other two cross-questions, I wasn't present during the conversations referred to and therefore cannot say whether those two answers are correct or not.

LEVEN J. GWINN.

Adjourned *sine die.*

1149 & 1150 United States Circuit Court in the District of Maryland.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY
vs.
BOYDEN POWER BRAKE CO.; GEORGE A. Boyden, President; Charles B. Mann, Secretary, William Whitridge, Treasurer.
} In Equity. No. 321.

I, George Morris Bond, a United States commissioner as aforesaid, before whom the within depositions were taken, do hereby certify that on the 4th day of April, 1894, and on the various days adjourned therefrom, ending on the 13th day of April, 1894, the several sittings hereinafter noted were attended by counsel of the complainants and defendants in the above-entitled cause and by the witnesses, George A. Boyden, who was recalled, and Leven J. Gwinn, and that said Gwinn was by me duly sworn, and the testimony of both witnesses was then reduced to writing by my sworn clerk, and thereafter subscribed by the said witnesses.

And I do further certify that I am not of counsel or attorney for either of the parties to the said cause, and that I am not interested in the event of the said cause.

Given under my hand and seal at the city of Baltimore, within the district of Maryland, this thirteenth day of April, in the year of our Lord one thousand eight hundred and ninty-four.

[COM'R'S SEAL.]

GEORGE MORRIS BOND,
U. S. Commissioner for Maryland.

1151 DEFENDANTS' EXHIBIT "COPY OF WESTINGHOUSE FILE-WRAPPER AND CONTENTS" OF PATENT NO. 360,070.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the files of this office of the file-wrapper and contents in the matter of the letters patent granted George Westinghouse, Jr., March 29, 1887, number 360,070, for improvement in fluid-pressure automatic brake mechanism.

In testimony whereof I, C. E. Mitchell, Commissioner of Patents, have caused the seal of the Patent Office to be affixed this [SEAL.] 14' day of December, in the year of our Lord one thousand eight hundred and eighty-nine, and of the Independence of the United States the one hundred and fourteenth.

C. E. MITCHELL,
Commissioner.

1152 To the Commissioner of Patents:

Your petitioner, George Westinghouse, Jr., residing at Pittsburgh, in the county of Allegheny and State of Pennsylvania, a citizen of the United States, respectfully prays that letters patent of the United States may be granted to him for the improvements in fluid-pressure automatic brake mechanism set forth in the annexed specification; and he hereby appoints J. Snowden Bell, [George H. Christy,]* of Pittsburgh, Pennsylvania, his attorney, with full power of substitution and revocation, to prosecute this application, to alter and amend the specification, to appeal or withdraw in case of rejection, to receive the patent when granted, and to transact all business in the Patent Office relative thereto.

GEORGE WESTINGHOUSE, JR.

[* Words enclosed in brackets erased in copy.]

BLEED THROUGH POOR COPY

1153 *Specification.*

To all whom it may concern:

Be it known, that I, George Westinghouse Jr. residing at Pittsburgh in the county of Allegheny and State of Pennsylvania, a citizen of the United States, have invented or discovered certain new and useful improvements in fluid-pressure automatic brake mechanism of which improvements the following is a specification:

1154 The object of my invention is to enable the application of brake-shoes to car wheels by fluid pressure to be effected with greater rapidity and effectiveness than heretofore, more particularly in trains of considerable length, as well as to economize compressed air in the operation of braking by utilizing in the brake-cylinders the greater portion of the volume of air which, in former practice, was directly discharged into the atmosphere. To this end, my invention, generally stated, consists in a novel combination of a brake-pipe, an auxiliary reservoir, a brake-cylinder, and a "triple-valve" device governing, primarily, communication between the auxiliary reservoir and the brake-cylinder, and secondarily, communication directly from the brake-pipe to the brake-cylinder. The improvements claimed are hereinafter fully set forth.

In the application of the Westinghouse automatic brake as heretofore and at present commonly in use, each car is provided with a main air pipe, an auxiliary reservoir, a brake-cylinder, and a triple valve, the triple valve having three connections, to wit: one to the main air-brake pipe, one to the auxiliary reservoir, and one to the brake-cylinder. The main air pipe has a stop-cock at or near each of its ends, to be opened or closed as required and is fitted with flexible connections and couplings for connecting the pipes from car to car of a train so as to from a continuous line for the transmission of compressed air from a main reservoir supplied by an air pump on the engine. When the brakes are off or released, but in readiness for action upon the wheels of the train, the air which fills the main reservoir and main air pipes has a pressure of from sixty-five to seventy-five pounds

2

1155 to the square inch, and, by reason of the connections referred to, the same pressure is exerted in the casings of the triple valves on both sides of their pistons and in the auxiliary reservoirs connected therewith. At the same time passages called release ports are open from the brake-cylinders, to the atmosphere. When it is desired to apply the brakes, air is allowed to escape from the main air pipes through the engineer's valve, thereby reducing the pressure in the main air pipes, whereupon the then higher pressure in the auxiliary

reservoirs moves the pistons of the triple valves, so as to first close the passages from the triple valves to the brake-pipe and at the same time close the release ports of all the brake-cylinders, and then open the passages from the auxiliary

to the brake-cylinders

reservoirs, ^ the pistons of which are forced out by the com-

Insert
Jan. 19, '87.

pressed air thereby admitted to the brake-cylinders, applying the brakes by means of suitable levers and connections, all of which mechanism is fully shown in various letters patent granted to me.

The application of the brakes with their full force has heretofore required a discharge of air from the main pipe sufficient to reduce the pressure in said pipe below that remaining in the auxiliary reservoir after the brakes have been fully applied, and it has been found that while the brakes are sufficiently quick in action on comparatively short trains, their action on long trains of from thirty to fifty cars, which are common in freight service under present practice, is in a measure slow, particularly by reason of the fact that

required to be discharged from — to set the brakes

all the air ^ [in]* the main pipe ^ must travel from the rear of the

Insert
Feb. 5, '87.

train to a single discharge opening on the engine. This dis-

3

1156 charge of air at the engine has not only involved a serious loss of time in braking, but also a waste of air. Under my present invention a quicker and more efficient action of the brakes is obtained, and air which has been heretofore wasted in the application of the brakes is almost wholly utilized to act upon the brake pistons.

In the accompanying drawings: Figure 1, is an inverted plan view of a railroad car illustrating the application of my invention; Fig. 2, a longitudinal section, on an enlarged scale, through the triple valve, at the line *x*, *x*, of Fig. 4; Fig. 3, a transverse section through the same at the line *y*, *y*, of Fig. 2; Fig. 4, a bottom plan view of the cap or drain-cup of the triple valve; Fig. 5, a longitudinal section through the triple valve, at the lines *z*, *z*, of Fig. 3, and *w*, *w*, of Fig. 6; Fig. 6, a partial bottom view of the triple valve, and; Fig. 7, a longitudinal central section through the brake-cylinder and auxiliary reservoir, with the triple valve in elevation.

In the practice of my invention, each railroad car 1, on which it is applied, is as heretofore provided with a main air pipe 2, governed by stop-cocks 3, adjacent to its ends, and

[* Word enclosed in brackets erased in copy.]

having a flexible connection 4, and coupling 5, at each end to admit of being coupled to the main pipe of the tender or the adjacent car or cars of a train. An auxiliary reservoir 6, and brake-cylinder 7, are secured in convenient position below the sills of the car, the brake-cylinder having a piston 52, by the movement of which, through a system of lever connections which do not form part of my present invention, the brake-shoes 9, are applied to and released from the wheels

4

1157 of the car, compressed air being supplied to and released from the brake-cylinder 7, as the pressure in the main air pipe is reduced or reinstated respectively, by means of a triple valve 10, the casing or chest of which communicates with the main air pipe, the auxiliary reservoir, and the brake-cylinder.

So far as the performance of its preliminary function in ordinary braking is concerned, that is to say, effecting the closure of communication between the main air pipe and the auxiliary reservoir, and the opening of communication between the auxiliary reservoir and the brake-cylinder in applying the brakes, and the reverse operations in releasing the brakes, the triple valve 10, accords substantially with that set forth in letters patent of the United States No. 220,556, granted and issued to me October 14, 1879, and is not therefore, saving as to the structural features by which it performs the further function of effecting the direct admission of air from the main air pipe to the brake-cylinder, as presently to be described, claimed as of my present invention. Certain of its elements devised and employed by me prior thereto, will however be herein specified in order to render its construction and operative relation to other members of the brake mechanism fully intelligible.

Insert Feb. 5, '87. The case or chest in which the operative mechanism of the triple valve 10, proper is mounted, is fixed under or on [to]* the car body in any convenient position relatively to the auxiliary reservoir 6, and brake-cylinder 7, being, in this instance, shown as secured directly to one end of the auxiliary reservoir, in line axially therewith and with the brake-cylinder which is secured to its opposite end. The triple-valve case is fitt-

5

1158 ed at one end with a cylindrical sleeve or bushing 11, which is bored out truly and forms the chamber of a piston 12, which is fixed upon a stem 13, carrying, as in my letters patent No.

[* Word enclosed in brackets erased in copy.]

220,556 before mentioned, a slide-valve 14, which controls communication between the auxiliary reservoir and the brake-cylinder and between the brake-cylinder and release port 15, respectively. The auxiliary reservoir 6, is continuously in communication with the chamber 11, on one side of the piston 12, through the longitudinal chamber 24, of the case in which the slide-valve 14, moves, and the triple-valve case communicates, by a passage 16, with the brake-cylinder, and, by a passage 17, with the main air pipe 2. The passage 17, leading from the main air pipe, communicates, by a passage 18, with the cap, or, as it is ordinarily termed, the drain-cup, 19, of the triple valve, from which passages 20, lead into the piston chamber 11. A four-way cock 21, controls the passages 16, 17, 18, and a passage 22, leading to a port 23, in the face or seat of the slide-valve 14. When in the position shown in the drawings, communication is continuously maintained between the main air pipe 2, and piston chamber 11, through the passages 17 and 18, drain-cup 19, and passages 20, and by turning the cock 21, so as to establish communication between the passages 16 and 17, the triple valve and auxiliary reservoir will be cut out from the main air pipe, and the mechanism can be operated as a non-automatic brake, the admission of air under pressure to the main air pipe and brake-cylinder effecting, in such case, the application of the brakes. The entire brake mechanism of the car, other than the main air pipe, may be put out of action, when for any reason required, by turning

6

1159 the cock 21, into position to cover the passages 16 and 18, the main air pipe then serving only for the transmission of air between the portions of the train line made up by the main air pipes of the remaining vehicles.

The slide-valve 14, is loosely connected with the stem 13, of the piston 12, and, by a pin 25, extending across the stem and fixed in the side plates of the valve, is prevented from being separated from the stem when removed for examination; it is held up to its seat in the chamber 24, by a spring 26. The valve partakes in the reciprocating movements of the stem 13, being moved in one or the other direction by a collar 27, and a shoulder 28, respectively, on the stem. Said collar and shoulder are located at a distance apart slightly greater than the length of the valve 14, so that a limited degree of traverse of the stem 13, and piston 12, in each direction is effected without imparting movement to the valve. A graduating valve 29, secured upon a stem 30, which is moved by the piston stem 13, governs a passage 31, in the slide-valve 14, said passage communicating, by a lateral port 32, with the valve chamber 24, and, consequently, with the auxiliary reservoir. A cavity or passage 33, is formed on the face of the slide-valve 14, of such length as to establish

communication during a portion of the traverse of the valve between the port 23, of the valve chamber 24, which is open to the passage 16, leading to the brake-cylinder, and a port 34, communicating with the relief port 15. The construction and relative arrangement of the piston stem 13, slide-valve 14, and graduating valve 29, are substantially similar to those of the corresponding parts as heretofore employed by me

7

1160 and exemplified in my letters patent No. 220,556, but, under my present invention, these are supplemented by a port 35, leading from the end of the valve adjacent to the opening of the chamber 24, which communicates with the auxiliary reservoir, to the face of the valve, so as, at the limit of traverse of the piston stem in the application of the brakes, to establish communication, directly through said passage, between the auxiliary reservoir and the port 23, and passages 22 and 16, leading to the brake-cylinder.

The piston stem 13, abuts, when the stem 13, and piston

Nov. 27, '86. 12, are moved for [from]* the major portion of their traverse towards

the drain-cup 19, against a stem 36, which is fitted to slide freely in line axially with the stem 13, in an open-ended bushing 37, in the end of the drain-cup 19, adjoining the piston chamber 11, and in guide formed in a screw-cap 38, closing the opposite end of the drain-cup. A spring 39, surrounding the stem 36, and bearing against the inside of the cap 38, and against a collar 40, on the stem 36, maintains the latter in the position shown in Fig. 2, except when a sufficient pressure of air is admitted from the auxiliary reservoir to the piston chamber to overcome the resistance of the spring and effect movement of the piston 12, beyond the point at which its stem 13, comes in contact with the stem 36.

So far as hereinbefore described, the triple valve accords in all substantial particulars with and is adapted to operate similarly to those of my letters patent Nos. 168,359, 172,064, and 220,556, and, in order that it may perform the further functions requisite in the practice of my present invention, it is provided with certain additional members which

8

1161 will now be described. For the purpose of effecting the admission of air directly from the main air pipe 2, to the brake-cylinder 7, when it is desired to apply the brakes with great rapidity and full force, an auxiliary slide-valve 41, is connected to and moves with the stem 36, said valve working over

[* Word enclosed in brackets erased in copy.]

a face in the bushing 37, between the piston chamber 11, and drain-cup 19, and governing a port 42, in said face, leading into a chamber 43, adjoining the same. The valve 41, has lateral wings or plates, fitting on each side of the stem 36, between shoulders or collars thereon, and is held thereto, when the stem is removed between collars or shoulders thereon abutting against its ends, by a pin 44, in its wings, a spring 45, acting to hold it to its seat in the bushing 37, when in position. The chamber 43, communicates, by a passage 46, (Fig. 5) with a chamber 47, in the end of the case of the triple valve adjacent to the auxiliary reservoir, from which chamber a passage 48, leads through the auxiliary reservoir into the brake cylinder 7. The chamber 43, is further provided with a check-valve 49, which opens outwardly into and controls the passage of air into the passage 46, said valve being held to its seat by a light spring 50, and serving to prevent the return of air from the brake-cylinder when the pressure in the main air pipe is reduced below that in the brake-cylinder, as in the case of the separation of the cars of the train by the breaking of a coupling.

In the operation of the brake mechanism as above described, air from the main reservoir and main air pipe passes through the passages 17, 18, drain-cup 19, and passages 20, into the piston chamber 11, forcing the piston 12, to the left-

1162 hand extremity of its stroke and uncovering a small feeding groove 51, in the piston chamber, through which air passes into the auxiliary reservoir 6, until the pressure in the latter is equal to that in the main air pipe, the brake-cylinder being meanwhile in communication with the atmosphere through the passages 16 and 22, valve cavity 33, and ports 23, 34, and release port 15. To apply the brakes in making ordinary stops, a portion of the air is discharged from the main air pipe by the engineers' valve, thereby correspondingly reducing the pressure in the main air pipe, whereupon the higher pressure in the auxiliary reservoir moves the piston 12, to the right, covering the feeding grove 51, and thus preventing the return of air from the auxiliary reservoir to the main air pipe, the movement of the piston continuing until arrested by the decrease of pressure in the auxiliary reservoir, or by the stem 36, and its spring 39. The movement of the slide-valve 14, then closes the port 23, preventing escape of air from the brake-cylinder, and places the passage 31, partly or wholly in communication with the port 33. The small auxiliary valve 29, having been meanwhile unseated, by the movement of the piston stem, compressed air from the auxiliary reservoir passes through the lateral port 32, and passage 31, of the slide-valve 14, and the passages 22, and 16, of the triple-valve case to the brake-cylinder, forcing out the piston, and,

through an appropriate system of levers and connections, applying the brakes. When the pressure in the auxiliary reservoir has in this operation, been reduced by expansion into the brake-cylinder until it is slightly below the pressure in the main air pipe, the pressure on the air-pipe side of the piston

10

1163 12, forces the piston 12, in the opposite direction until the auxiliary valve 29, closes the passage 31, thereby arresting the further flow of air from the reservoir to the brake-cylinder and holding the brakes with a force proportionate to the reduction of pressure in the brake-pipe. To release the brakes, the pressure in the main air pipe is increased by admitting air from the main reservoir, whereupon the resultant increase of pressure in the piston chamber 11, forces the piston 12, back to its original or normal position, permitting the escape of air from the brake-cylinder 7, the piston 52, of which is returned to its position by a spring 53, releasing, in its backward movement, the brake-shoes 9, from the wheels, and at the same time the auxiliary reservoir is recharged. The admission of air to the brake-cylinder through the passage 31, which is opened just before the piston stem comes in contact with the graduating stem, and which corresponds to the feed-passage heretofore employed, suffices for the ordinary requirements of braking in regular service.

In the event however of its becoming necessary to apply the brakes with great rapidity and with their greatest available force, the engineer, by means of the valve at his command instantly discharges sufficient air from the front end of the main air pipe, to effect a sudden reduction of pressure of about twenty pounds per square inch therein, whereupon the piston 12, of the triple valve is forced to the extreme limit of its stroke in the direction of the drain-cup 19, carrying with it the stem 36, and auxiliary slide-valve 41, which instantly uncovers the port 42, and discharges air from the main air pipe through the opening of the check-valve 49, and the

11

1164 passages 46 and 48, to the brake-cylinder, and each car being provided with one of these devices, it will be seen that they are successively moved with great rapidity, there being practically, on a train of fifty cars, fifty openings for discharging compressed air from the main pipe instead of the single opening heretofore commonly used. Not only is there a passage of considerable size opened from the brake-pipe on each car, whereby the pressure is more quickly reduced, but the air so discharged is utilized in the performance of preliminary work, it being found in practice that the air so taken from the pipe will exert a pressure of about twenty-five

pounds in the brake-cylinders. When the piston 12, arrives at the extremity of its stroke, as above specified, the supplemental port 35, of the slide-valve 14, is brought into communication with the port 33, and passages 22 and 16, which serves to discharge the reservoir pressure into the brake-cylinder, thereby augmenting the pressure already exerted in the brake-cylinder by the air admitted from the main air pipe. Upon the reduction of the pressure in the main air pipe below that in the brake-cylinders, as by the breaking in two of the train, the check-valve 49, closes communication between the passages 46 and 18, thereby preventing the return of the air from the brake-cylinder to the main air pipe. The feed-opening for the admission of air from the auxiliary reservoir to the brake-cylinder is purposely made of comparatively small diameter, it having been determined by experiment that the initial application of the brakes should not be made with maximum force, and this opening may be made of such size as to apply the brakes exactly in accord with the requirements of the

12

1165 most efficient work.

In using the terms "triple valve" and "triple-valve device," I refer to a valve device, however specifically constructed, having a connection with the main air or brake pipe, another with an auxiliary reservoir or chamber for the storage of power, and another with a brake-cylinder or its equivalent for the utilization of the stored power and with a release or discharge passage for releasing the operative power from the brake-cylinder, whether the valves governing these passages or connections are arranged in one or more cases and are moved by a piston or its equivalent or by a series of pistons or their equivalents, there being numerous examples in the art of constructions varying materially in appearance whereby these functions are performed, both in plenum and vacuum brake mechanisms.

While I have herein described my invention as applied in a brake mechanism utilizing air under pressure, such as is in general and approved use, I do not desire to limit myself to brakes so operated, as my improvements are likewise susceptible of application, without variation of principle, in connection with brakes worked by atmospheric pressure.

BLEED THROUGH POOR COPY

Substitute B. Jan. 20, '87.

Further, while in the specific construction described and shown, the function of admitting air from the main pipe is performed by a valve separate from that which effects the preliminary admission of reservoir pressure to the cylinder, a modification in which the same office is performed by a valve integral with the main valve and formed by an extension thereof, would be included in and embody the essential operative features of my invention.

13

1166 I claim as my invention and desire to secure by letters patent:

Substitute A. Jan. 19, '87.

1. In a brake mechanism, the combination of a main air pipe, an auxiliary reservoir, a brake-cylinder, and a triple valve provided with a device for admitting air directly from the main air pipe to the brake-cylinder, substantially as set forth.

2. In a brake mechanism, the combination of a main air pipe, an auxiliary reservoir, a brake-cylinder, and a triple valve having a piston whose preliminary traverse admits air from the auxiliary reservoir to the brake-cylinder and which by a further traverse, admits air directly from the main air pipe to the brake-cylinder, substantially as set forth.

3. In a brake mechanism, the combination of a main air pipe, an auxiliary reservoir, a brake-cylinder and a triple valve having a piston whose preliminary traverse admits air from the auxiliary reservoir to the brake-cylinder and which, by a further traverse, admits air directly from the main air pipe to the brake-cylinder and effects a second admission of air from the auxiliary reservoir to the brake-cylinder, substantially as set forth.

[Matter enclosed between rules erased in copy.]

4. The combination, in triple-valve device, of a case or chest, a piston fixed upon a stem and working in a chamber

14

1167 therein, a valve moving with the piston stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake cylinder and to the atmosphere respectively, and an auxiliary valve actuated by the piston stem and controlling communication between passages leading to connections with a main air pipe and with the brake-cylinder respectively, substantially as set forth.

5. The combination, in a triple-valve device, of a case or chest, a piston fixed upon a stem and working in a chamber therein, a valve moving with the piston stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere respectively, an auxiliary valve actuated by the piston stem and controlling communication between passages leading to connections with a main air pipe and with the brake-cylinder respectively, and a check or non-return valve interposed between the auxiliary valve and the passage leading therefrom to the brake-cylinder, substantially as set forth.

6. The combination, in a triple-valve device, of a case or chest, a piston fixed upon a stem and working in a chamber therein, a valve moving with the piston stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere respectively, an auxiliary stem mounted in the cap of the case in position to be moved longitudinally by the piston stem in the latter portion of its traverse in the direction required

15

1168 for the application of the brakes, a spring bearing against a collar on the auxiliary stem and against a fixed abutment, and an auxiliary valve connected to the auxiliary stem and controlling communication between passages leading to connections with a main air pipe and with the brake-cylinder respectively, substantially as set forth.

7. The combination, in a triple-valve device, of a case or chest, a piston fixed upon a stem and working in a chamber therein, an auxiliary valve actuated by the piston-stem and controlling communication between passages leading to connections with a main air pipe and with a brake-cylinder respectively, and a main valve connected to the piston-stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere respectively, said main valve having a supplemental port or passage which establishes communication between

the auxiliary reservoir and brake-cylinder connections at or near the limit of the traverse of the main valve in effecting

16

1169 the application of the brake under maximum pressure, substantially as set forth.

In testimony whereof, I have hereunto set my hand.

GEO. WESTINGHOUSE, JR.

Witnesses:

J. SNOWDEN BELL.
R. H. WHITTLESEY.

1170 STATE OF PENNSYLVANIA, County of Allegheny, } *ss:*

George Westinghouse, Jr., the above-named petitioner, resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, a citizen of the United States, being duly sworn deposes and says that he verily believes himself to be the original, first, and sole inventor of the improvements in fluid-pressure automatic brake mechanism described and claimed in the foregoing specification; that the same have not been patented to him, or to others with his knowledge or consent in any country, that the same have not to his knowledge been in public use or on sale in the United States for more than two years prior to this application, and he does not know and does not believe that the same were ever known or used prior to his invention thereof.

GEO. WESTINGHOUSE, JR.

Sworn to and subscribed before me this seventeenth day of November 1886.

[SEAL.]

R. H. WHITTLESEY,
Notary Public.

1171 In the United States Patent Office.

In the matter of the application of George Westinghouse, Jr. Improvement in fluid-pressure automatic brake mechanism. Filed Nov. 19, 1886. Serial No., 219,353.

Before the examiner. Room 38.

PITTSBURGH, *Nov. 26th*, 1886.

Hon. Commissioner of Patents.

SIR: I hereby amend the specification by cancelling the word "from," line 11, p. 8, and substituting "for."

Respectfully, J. SNOWDEN BELL, *Attorney*.

1172 DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
WASHINGTON, D. C., *Jan. 14th*, 1887.
Mailed " " "

No. 219,353. Fluid-pressure automatic brake. Filed Nov. 19th, 1886.

George Westinghouse, Jr., care J. Snowden Bell, Pittsburgh, Pa.:

Claims 1 & 2 are anticipated by patent No. 280,285 to G. A. Boyden, June 26th, 1883 (steam & air brake attachments).
It is desirable that a working model of the triple valve be furnished.

F. FOWLER, *Ex.*

T. J. HOGAN.

1173 In the United States Patent Office.

In the matter of the appl'n of George Westinghouse, Jr., for imp't in fluid-pressure automatic brake mechanism. Filed Nov. 19, 1886. Se. No., 219,353. } Before the Examiner. Room 38.

WASHINGTON, D. C., *Jan. 19th*, 1887.

Hon. Commissioner of Patents.

SIR: Acknowledging the official letter of 14th inst. I hereby amend the specification as follows, to wit:

In line 14, page 3, after "reservoirs," insert: "to the brake cylinders."

Cancel the comma after "air," line 15, page 3.

Cancel claim 1, and substitute:

"1. In a brake mechanism, the combination of a main air pipe, an auxiliary reservoir, a brake-cylinder, a triple valve, and an auxiliary valve device, actuated by the piston of

BLEED THROUGH POOR COPY

A. the triple valve, and independent of the main valve there for admitting air, in the application of the brake, directly fro the main air pipe to the brake-cylinder, substantially as set fort

It is respectfully submitted that while the Boyden patent No. 280,285 referred to, shows what the inventor terms "a always-open one-way passage" by which communication may l established under certain conditions between the main air pipe
1174 train-pipe, and hence might be held to meet the terms of tl claim as originally broadly drawn, yet it fails to embody a d vice which in structure or function corresponds with the auxiliary valve of applicant, which in no sense relates to "an always-open one-way passage."

The amended claim above submitted prescribes a valve device actuated by the piston of the triple valve for admitting air to the brake-cylinder in the application of the brake, while Boyden's check-valve *d*, is not actuated by the piston, and is designed to recharge the auxiliary reservoir and brake-cylinder while the brakes are on.

It is submitted as to claim 2, that a piston which by its preliminary traverse admits air from the auxiliary reservoir to the brake cylinder and by its further traverse admits air directly from the main air pipe to the brake-cylinder, as set forth in said claim, is not found in the Boyden patent, the check-valve *d*, of which is described as actuated by the manipulation of the cock *q*, on the locomotive "to recharge and continue charging the reservoir and brake-cylinder while the brakes are applied." (Boyden patent, lines 56–69, page 2.)

Further, it will be observed that the space between the lower end of Boyden's piston G and the port in the left-hand side thereof governing the passage D, is equal to the width of the face of the upper end of the slide-valve H, so that the admission will be coincident through the passages C′ and D, thus evidencing tha both are opened by the preliminary traverse of the piston.

It is to be understood that applicant does not seek to broadly claim a device for admitting air directly from the main air pipe to the brake-cylinder, as the four-way cock long hereto
1175 fore employed by him (similar to the cock K of the Boyden patent) would be a structure of such character. When however the triple valve is provided with an auxiliary valve operated by its piston which performs a new function additional to that of the triple valve as previously employed, it is believed that such combination is whol-y novel.

With reference to the Boyden invention as shown in figure 2, it will be noticed that the upper piston 1, is intended to be acted upon by the pressure in the chamber above it in applying the brakes, and that the pressure in this chamber is supposed

to be maintained at a constant point after the air within it has expanded. Practice has shown that it is utterly impossible to pack a piston or device such as illustrated so that the valve constructed as shown would be an impracticable device. Boyden had no idea of quickly applying his brakes, and has provided no means whereby the brakes can be applied with a moderate amount of force, as is fully provided for by applicant and Boyden's construction involves the full application of the brakes in all cases, which would render the device inoperative for the obvious requirements of railway service.

He seems to have conceived the idea of charging the brake-cylinder and reservoir when the brakes are on, assuming that the pressure in the brake-cylinder and reservoir might leak away, and might, therefore, need replenishing.

The check-valve *d*, is provided with a spring tending to hold it to its seat. If this spring were made with considerable potension, the piston and slide-valve would be forced up to the position shown in the drawing without the possibility of applying more pressure to the brake-piston. If, on the contrary, the valve
1176 *d* is made so that the resistance to the passage of air is less than
the resistance of the piston, the reservoir and brake-cylinder will be charged and the release of the brakes will be prevented unless the chamber L is made of nearly the same proportion as the auxiliary reservoir.

In the Boyden invention, to apply the brakes with full force requires the discharge of the greater portion of the air from the brake-pipe, after which he proposes to further increase the pressure in the brake-cylinder by allowing air to pass the valve *d*. If he were to attempt to apply the brakes with a moderate amount of force, the piston and slide-valve would descend admitting some air to the brake-cylinder, and would be released unless the piston I were to be made air-tight.

The recharging of the auxiliary reservoir where the ordinary Westinghouse triple valve is used, requires only a small passage through or by the piston. The feed-groove, which is shown in the cylinder, could be extended to a point reaching below the piston when the triple valve is in its middle position, that is, in the position to prevent air from passing either from the reservoir to the brake-cylinder, or from the brake-cylinder to the atmosphere. This feed-groove would allow the air to pass around the piston and recharge the reservoir. Experiments of this kind have been repeatedly made, but the difficulties arising from the inability to release the brake prevent the use of such a construction.

A model is filed herewith as suggested by the office.

Reconsideration upon the above points and amendment is requested.

Respectfully, J. SNOWDEN BELL,
Att'y for Applicant.

1177 In the United States Patent Office.

In the matter of the appl'n of George Westinghouse, Jr., for imp't in fluid-pressure automatic brake mechanism. Filed Nov. 19, 1886. Se. No., 219,353. } Room 38.

WASHINGTON, D. C., *Jan.* 19*th*, 1887.

Hon. Commissioner of Patents.

SIR: In further acknowledgement of the official letter of 14th inst, I hereby amend the specification as follows: to wit,

Cancel all between the word "Further," line 21, page 13, and "invention," line 29, same page, both inclusive, and substitute:

B. "I am aware that a construction in which 'an always open one-way passage' from the main air pipe to the brake-cylinder
is uncovered by the piston of the triple valve simultaneously with
the opening of the passage from the auxiliary reservoir to the brake-cylinder, has been heretofore proposed, and such construction, which involves an operation different from that of my invention, I therefore hereby disclaim."

Respectfully, J. SNOWDEN BELL,
Attorney for Applicant.

1178 DEPARTMENT OF THE INTERIOR,
U. S. PATENT OFFICE,
WASHINGTON, D. C., *Jan.* 31, 1887.

Petition.

Application of Geo. Westinghouse, Jr. Serial No., 219,353. Invention: Fluid-pressure automatic brake mechanism.

This petition is referred to the examiner in charge of division 18 for recommendation.

In case he recommend adversely he will state his reasons therefor.

M. V. MONTGOMERY,
Commissioner.

1179 & 1180 *Memorandum of Fee Paid at U. S. Patent Office.*

Serial No., 219,353. —— —, 188–.

Inventor:
George Westinghouse, Jr.

Patent to be issued to—
—— ——.

Name of invention, as allowed:
Fluid-pressure automatic brake mechanism.

Date of payment:
—— —, ——.

Fee:
$20.

Solicitor:
J. Snowden Bell.

Date of filing:
Nov. 19, 1886.

Date of circular of allowance:
Jan'y 22, 1887.

Send patent to—
George H. Christy, box 1034, Pittsburgh, Pa.

1181 In the United States Patent Office.

In the matter of the application of George Westinghouse, Jr. Improvement in fluid-pressure automatic brake mechanism. Filed Nov. 19th, 1886. 188–. Serial No., 219,353.

Before the examiner. Room 38.

PITTSBURGH, *Jan. 29th*, 1887.

Hon. Commissioner of Patents.

SIR: I hereby request that the following amendments, relating to minor-inaccuracies of statement and not affecting the merits, may be made in the specification, in accordance with the provisions of rule 77, to wit:

Cancel the word "in," line 28, page 3 and substitute

1✓ the words "required to be discharged from"

In same line after "pipe" insert: "to set the brakes"

Cancel the word "[illegible]" line 24, page 5, and substi-

1✓ tute "under or on"

Respectfully, J. SNOWDEN BELL, *Attorney.*

Recommended that above request be granted.
T. FOWLER, *Ex.*

Approved.
M. V. MONTGOMERY, *Commissioner.*

Feb. 4, '87.
91—403

BLEED THROUGH POOR COPY

1182 Serial No., 219,353. Ex'r Book No. $\frac{191}{13}$.

1886.

Patent No. 360,070. Div. 18

George Westinghouse, Jr.,
Of Pittsburgh,
County of ——,
State of Pennsylvania.
Invention: Fluid-pressure automatic brake mechanism.

Parts of application filed.		
	Petition,	Nov. 19, 1886.
	Affidavit,	" " "
	Specification,	" " "
	Drawing, 3 sh'ts,	" " "
	Model, January 19th, 1887.	
	Specimen, ——.	
	First fee, cash, $15, Nov. 19, 1886.	
	" " cert., ——.	

App. filed complete Nov. 19, 1886.
Examined Jan. 20, '87. F. Fowler, ex.
Countersigned: T. W. Dick Bullock, for Commissioner.
Jan. 21, '87.
Notice of allowance, Jan. 22'', 1887.
Final fee, cash, $20, Mar. 3, 1887.
" " cert., —— —, 188–.
Patented Mar. 29, 1887.
Att'y, or P. O. address: J. Snowden Bell, Pittsburgh, Pa.

1183 & 1184 (2–024.) Serial No., 219,353.

Issue division.

All communications should be addressed to "The Commissioner of Patents, Washington, D. C."

DEPARTMENT OF THE INTERIOR,
U. S. PATENT OFFICE,
WASHINGTON, D. C., *Jan.* 22, 1887.

George Westinghouse, Jr., c. o. J. S. Bell, Pittsburg, Pa.

SIR: Your application for a patent for an improvement in fluid-pressure automatic brake mechanism, filed Nov. 19th, 1886, has been examined and allowed.

The final fee, twenty dollars, must be paid, and the letters patent bear date as of a day not later than six months from the time of this present notice of allowance.

If the final fee is not paid within that period the patent will be withheld, and your only relief will be by a renewal of the application, with additional fees, under the provisions of section 4897, Revised Statutes. The office aims to deliver patents upon the day of their date, and on which their term begins to run; but to do this properly applicants will be expected to pay their final fee at least twenty days prior to the conclusion of the six months allowed them

by law. The printing, photolithographing, and engrossing of the several patent parts, preparatory to final signing and sealing, will consume the intervening time, and such work will not be done until after payment of the necessary fees.

When you send the final fee you will also send, distinctly and plainly written, the name of the inventor and title of invention as above given, date of allowance (which is the date of this circular), date of filing, and, if assigned, the names of the assignees.

If you desire to have the patent issue to assignees, an assignment containing a request to that effect, together with the fee for recording the same, must be filed in this office on or before the date of payment of final fee.

Additional copies of specifications and drawings will be charged for at the following rates: Single copies, uncertified, 25 cents; twenty copies or more, 10 cents each. The money should accompany the order.

Very respectfully,

M. V. MONTGOMERY,
C. E. MITCHELL,
Commissioner of Patents.

[Printed on the margin:] The within title is that given by the examiner in charge as most appropriate to your invention. Should you desire a change in the same, satisfactory reasons must be given therefor on or before the payment of the final fee.

[Printed across the face:] ☞ In remitting the final fee give the serial number at the head of this notice.

1185 121. Steam engines,
Steam & air brakes.

1886.

Contents. G.

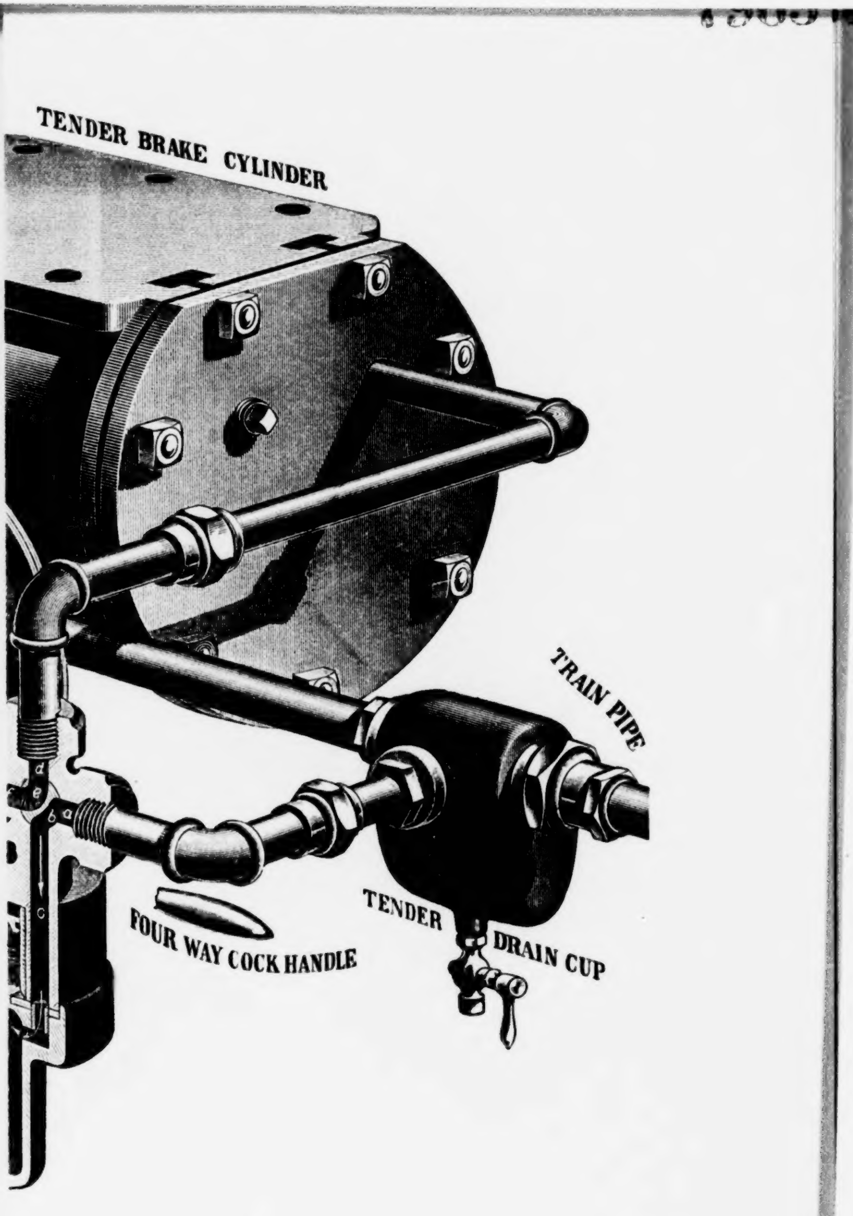
½. Application, 1 papers.
1. Amend't, Nov. 27, '86.
2. Rej., Jan. 14th, 1887.
3. Amend't A, Jan. 19, '87.
4. Amend't B, Jan. 20, '87.
5. Request, Jan. 31st, 1887.
6. Amend't (under rule 77), Feb. 5, '87.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.

Title: Improvement in fluid-pressure automatic brake mechanism.

J. F. F.
M. H.

1186 (Here follows diagram marked pp. 1187 & 1188.)

BLEED THROUGH POOR COPY


TENDER BRAKE CYLINDER
TRAIN PIPE
TENDER
DRAIN CUP
FOUR WAY COCK HANDLE

1189–1191 *Extracts from "Defendants' Exhibit Westinghouse* 1886 *Instruction Book."*

From page 3.

Our attention has been repeatedly directed to the importance of furnishing a complete and concise description of our brake apparatus, to be placed in the hands of those who are engaged in its operation or its maintenance. In the present book we have illustrated the general construction of the brake and all the more essential parts.

From page 7.

Too much importance cannot be attached to that portion of the instructions stating that engineers should use care and moderation in applying the brakes for ordinary stops. By applying them at a fair distance from the station, with moderate force, the train is stopped gently and without inconvenience to the passengers, while if they are thrown on with the utmost force possible, the train is jerked in a manner that is extremely disagreeable to the passengers.

Extract from "Defendants' Exhibit Westinghouse 1890 *Instruction Book."*

From page 19.

The plain automatic triple valve.

A perspective view of the plain automatic triple valve and locomotive-tender brake apparatus, is shown in plate 1, Fig. 3, and cross-sections of the triple valve in Figs. 4 and 4*a*, which will clearly show its construction. It is desirable that this triple valve be perpetuated for use with locomotive driving-wheel and tender brakes, to give a slightly slower action to the brakes thereon in cases of emergency action of the quick-action apparatus on cars.

The construction and operation of the plain automatic triple valve is substantially the same as that of the quick-action form, the quick-action valves being omitted, and pressure used only from the auxiliary reservoir in applying the brakes, and will not, therefore, require specific description.

1193 UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., of Schenectady, New York.

Improvement in Steam-power Brake Devices.

Specification forming part of Letters Patent No. 88929, dated April 13, 1869.

To all whom it may concern:

Be it known that I, George Westinghouse, Jr., of Schenectady, in the county of Schenectady and State of New York, have invented a new and useful improvement in power car-brakes; and I do hereby declare the following to be a full, clear, and exact description thereof, reference being had to the accompanying drawing, making a part of this specification, in which—

(Here follows diagram marked p. 1192.)

Figure 1 shows by a side elevation, partly in section, my improvement as mounted on and applied to an ordinary platform railroad-car. Fig. 2 is a sectional plan view as formed by a horizontal plane passing through the brake-cylinder, just below the body of the car. Fig. 3 is a vertical, and Fig. 4 is a cross section of the three-way cock by which I admit or cut off the supply of air to the brake. Fig. 5 is an outside view, and Fig. 6 is a longitudinal section of my improved coupling for uniting the brake-pipes of contiguous cars.

Like letters represent like parts of each.

My invention relates to the construction of a power car-brake for railway-cars or other like vehicles, to be operated by compressed air or other elastic compressible fluid; and the nature of it consists, first, in the use of an auxiliary engine for compressing the air in a reservoir, from which it is to be conducted by suitable pipes and applied to operating the brakes, and also for pumping feed-water into the boiler, either or both; second, in the construction of a reservoir for storing up the power to be derived from air or other elastic fluid under compression, such reservoir having a pipe or pipes leading to one or more brake-cylinders on or attached to each car, with a valve or cock in each pipe for turning on or off the supply of air; third, in the construction and combination of devices by which the power thus communicated to the piston of the brake-cylinder may be from it applied to operating an ordinary hand-brake, or any other known form of simple or compound brake; fourth, in the construction of an improved coupling for uniting the brake-pipe of contiguous cars, so made that when coupled they shall be always open for the passage of air to the brake-cylinders, but if uncoupled, when the brakes are down, the pressure of the air in the pipes will instantly close them.

To enable those skilled in the art to make and use my invention, I will proceed to describe its construction and manner of use.

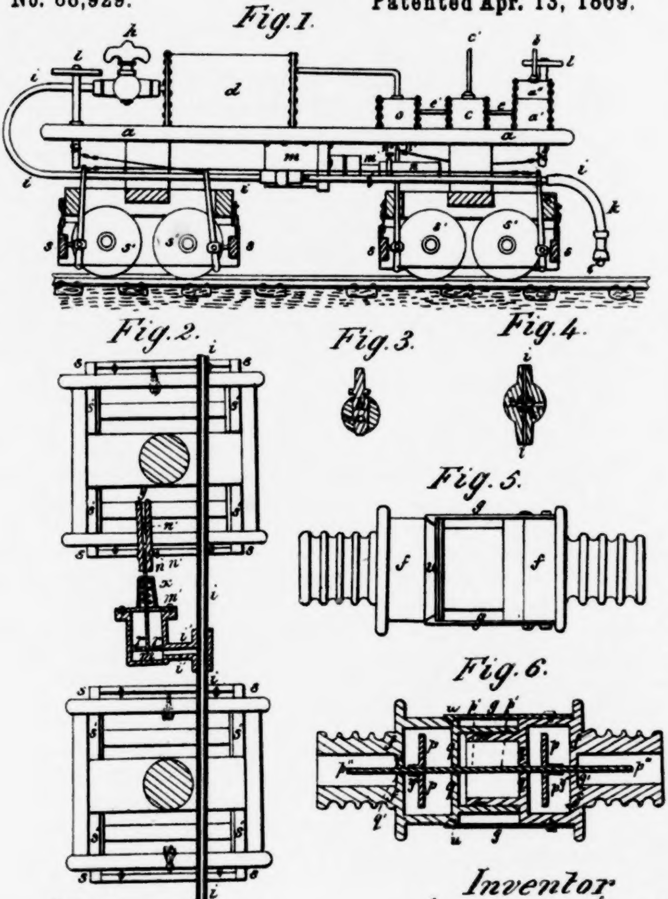
7965

No. 403 & 426.
Westinghouse Co v. Boyden Co. } p. 1192

G. WESTINGHOUSE, Jr.

STEAM POWER BRAKE.

No. 88,929. Patented Apr. 13, 1869.



Witnesses
Thos. B. Kerr
R. C. Dravohall

Inventor
George Westinghouse Jr
by Bakewell & Christy
his Att'ys.

a represents a platform-car on which is mounted an auxiliary engine, *a′ a″*, a feed-water-pumping cylinder, *c*, and an air-pump, *o*, and an air-reservoir, *d*. A single piston-rod connection, *e e′*, may answer for both pumps; or one piston-rod may lead from the auxiliary engine *a′ a″* to the feed-water pump *c*, and another to the air-pump *o*. In either case the operation would be the same. *b* is a steam-pipe leading from the locomotive-boiler to the auxiliary engine *a′ a″*. A water-pipe extends from the water-tank on the tender to the pumping-cylinder *c*, and by a piston working therein, water is fed through the pipe *c′* to the boiler. The air-pump *o* has the usual valves, and works on the principle of the ordinary air-pump, and compresses the air into the reservoir *d*. Each of these cylinders is fitted with the valves and cocks necessary to their successful operation.

From the reservoir *d* an air-pipe, *i*, leads down and back along under the cars of the train, the communication through the pipe being opened and closed by a three-way cock, *h*, presently to be described.

At any convenient point on or under each car a brake-cylinder, *m*, is attached, having a piston working closely therein. A pipe, *i′*, leads from the main pipe *i* to each brake-cylinder *m*, opening into it back of the piston *r*. The piston-stem *m′* plays through the opposite end of the brake-cylinder *m*, and at its outer end may be bifurcated, so as to operate against the brake-lever *n′*; or an adjustable bifurcated head, *n*, may be set thereon by a set-screw *n″*. The brake-lever *n′* and the brakes connected therewith may be simple or compound, or of any known or desirable construction. As shown, they are of the ordinary style. It will be observed that, with the construction and arrangement shown, the operation of the "doctor" or feed-water pump, and of the brakes, is in no way dependent on the movements of the locomotive. If steam be up, water can be fed into the boiler, even when the locomotive is standing, which end is a desirable one, since it is sometimes far from convenient
1194 to run a locomotive and train forward or back merely to replenish the supply of water in the boiler, and still more so at other times to slack up a train for the same purpose. In like manner, the operation of the auxiliary engine *a′ a″* may be so regulated, even with the locomotive running at its highest speed, and with an occasional or even frequent application of the brakes, that a uniformly constant pressure of air can be preserved in the reservoir *d*. This auxiliary engine *a′ a″*, with the pumps *c o* and reservoir *d*, may, and probably should be for convenience, mounted on or attached in some way to the locomotive or tender. As they are small, light, and not costly, they can be easily and cheaply applied. If it be desired to operate either alone, the connecting-valves of the other may be closed, and its piston work *in vacuo*, without in the least interfering with the working of the other.

The reservoir *d* being filled with compressed air, whenever it is desirable to apply the brakes the cock *h* is turned, and the air rushes along, through the pipes *i i′*, into the brake-cylinder *m*, forces its rod *m′* against the brake-lever *n′*, whereby the brakes *s* are instan-

taneously applied to the wheels s', and the speed of the train a once checked. Of course, the more the air is compressed in the reservoir d, the more powerful will be its action on the brakes.

The cock h is a three-way cock—that is, it opens on three sides When turned as in Fig. 4, the air flows freely through from the reservoir d, as described. On being turned one-quarter way around the orifice z comes into the tubular opening of the pipe i, leading to the brakes, and the orifice z' coincides with the orifice in the side of the valve-seat, so that communication is cut off from the reservoir d to the brakes, but opened from the brake-cylinders to the external atmosphere. The excess of air then escapes. The spiral spring x, Fig. 2, carries the piston r of the brake-cylinder m back to the head of the brake-cylinder, and the brakes are off. The length of throw to be given to the brake-lever n' may sometimes vary somewhat, and hence I use the adjustable head n. The bifurcation y, whether made in the head n or in the stem m', is of such depth that if it be sometimes preferred to operate the brakes by hand, the levers n' will not be drawn out of the fork or slot of the bifurcated end; and to illustrate such use I have shown the ordinary hand-brakes l attached.

To provide for longitudinal motion of the cars independent of each other in starting or stopping, I use between each two cars a section of air-tight flexible pipe, k, made of idia-rubber, or india rubber and cloth, or other like flexible and air-tight material.

An important feature of my invention consists of the construction and combination of coupling-valves, which I use in the ends f of the pipe k, where they are jointed between cars. These valves are more perfectly illustrated in Fig. 6, where f f represent the adjacent or coupling ends of the pipes k of two consecutive cars. The ends f couple one into the other, and hooks g pass over the beveled shoulders u in the face of the coupling f, and prevent their coming uncoupled, except in case the car-coupling should break, or a car jump from the track, and then the hooks g would be disengaged and the coupling be uncoupled from each other. Inside each coupling f is a puppet-valve, p, having a stem, p', playing through a guide or diaphragm, q, the two stems being of such length that when the couplings f are coupled together the stems will come together end to end, and each force back the other, so as to throw its valve p free from its seat, and make an uninterrupted communication through the pipe i from the reservoir d to the last valve of the last car. The rear stems p'' play through guides or diaphragms q', and keep the valves p more carefully centered, so that the forward stems p' will always engage each other when the cars are coupled. The guides q q' should be open, or have openings, to admit of the passage from one pipe to the next of the compressed air. Then, when the pipes are uncoupled by the breaking of the car-coupling, or by a car leaving the track, the compressed air having been applied to the brakes, its pressure will cause the valves p to come against their seats on the guides q, thereby closing the ends of the pipe and keeping the brakes on or down. Thus the danger from accident will be materially decreased. The stems p'' are made with shoulders y'

which rest against the guides q' p' when the ends f are coupled and the valves p are opened. Consequently the valves p cannot set back against the guides q' to close them, nor can the compressed air, when admitted, close the valves p or either of them. When the pipes are coupled, the valves p must always be open. If they come uncoupled when filled with compressed air, they will be instantly closed, and must necessarily remain so. Hence, in the worst of disasters, the brakes will remain down if once applied.

Instead of the puppet-valves p, other forms of valves may be used, provided they be so arranged as to operate or open each other when the pipes f are coupled together. For this purpose flap-valves with stems may be used; also, instead of the diaphragms for guiding the stems, wings on the stems may be substituted. In that case the wings may be so made as to slide in the cylindrical or other shaped cavity of the couplings f.

The hooks g operate with sufficient rigidity to catch tightly in the grooves u, and hold the couplings f together against any ordinary force exerted longitudinally to which they would be subject; but by beveling slightly the holding shoulder of the grooves u, as shown, the hooks g would be disengaged, as in case of an
1195–1197 accident, by any force sufficient to throw the car from the track or by the breaking of the car-coupling. In lieu of this device, however, other devices performing the same function may be substituted—that is, other means may be used to accomplish the same end, provided they be such as will hold the couplings f together against the operation of any force to which in use they are ordinarily subject, but not such as to prevent their being automatically uncoupled in case of accident. At the same time all such devices should be so made that the couplings may be readily uncoupled by hand.

The particular advantages connected with the apparatus described, in addition to those above referred to, are, that the brakes are under the control of the engineer, and can be instantaneously applied at any time, and with any degree of power within the strength of the machinery employed, and the brakes can be as instantaneously loosened. They are simple in construction, cheaply made, and can be applied to and used in connection with or used without the ordinary hand-brakes. By the use of the auxiliary engine the operation of the brakes is made independent of the operation of the locomotive, so that much or little power can be stored up in the reservoir d at any time, whether the locomotive be running fast or slow, or not at all; and, if desired, all the force of the air-pump can be applied to the brakes over and above the force that can be stored up in the reservoir. By this mode of operating brakes in connection with the couplings described, in case of accident the brakes may be instantaneously applied, and kept "on" till the whole train, or each separate car, if the car-couplings break, be brought to a complete stand.

What I claim as my invention, and desire to secure by letters patent, is—

1. The auxiliary engine, with connections to, and in combination

with, the air-pump, air-reservoir, and brake-cylinder, substantially as hereinbefore set forth.

2. The auxiliary engine arranged to operate in connection with a railroad-locomotive, feed and water pumps, substantially in the manner hereinbefore set forth.

3. The reservoir *d*, with pipes *i*, leading to one or more brake-cylinders on, or attached to, each car, with a valve or cock in each pipe for turning on or off the supply of air, arranged substantially as above set forth.

4. The brake-cylinder *m*, in combination with the pipe *i'*, and piston-stem connecting with the brake-lever, substantially as hereinbefore set forth.

5. The adjustable head *n* on the piston-stem *m'*, in connection with the brake-lever *n'*, substantially as hereinbefore set forth.

6. The valves *p*, arranged in the adjacent ends of the couplings *f*, and so guided by stems and guides or diaphragms as to operate to open each other when the couplings *f* are united, and automatically to close when forcibly uncoupled, substantially as above set forth.

In testimony whereof I, the said George Westinghouse, Jr., have hereunto set my hand.

GEO. WESTINGHOUSE, JR.

Witnesses:

A. S. NICHOLSON.
G. H. CHRISTY.

1968

No. 403 & 426.
Westinghouse v. Boyden et al. } p. 1198

GEORGE WESTINGHOUSE, Jr.

Improvement in Steam Power Air Brakes and Signals.

No. 124,404. Patented March 5, 1872.

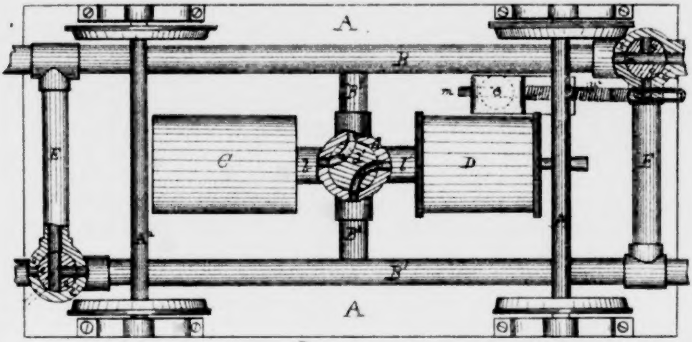


Fig. 1.

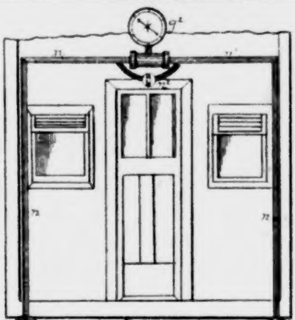


Fig. 3.

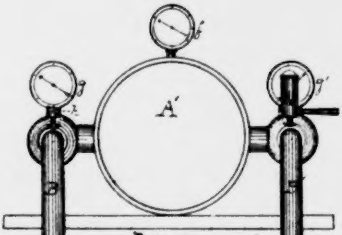


Fig. 2.

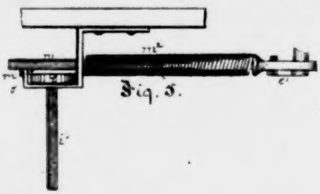


Fig. 5.

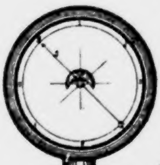


Fig. 4.

Fig. 6.

Witnesses:
James J Kay
E C Fitler

Inventor:
George Westinghouse
by Bakewell, Christy & Kerr,
his Attys.

1199 UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., of Pittsburg, Pennsylvania.

Improvement in Steam-power Air-brakes and Signals.

Specification forming part of Letters Patent No. 124,404, dated March 5, 1872.

Specification.

To all whom it may concern:

Be it known that I, George Westinghouse, Jr., of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful improvement in steam-power air-brakes and signal: and I do hereby declare the following to be a full, clear, and exact description thereof, reference being had to the accompanying drawing making a part of this specification, in which—

(Here follows diagram marked p. 1198.)

Figure 1 is an inverted view of a car-body with my improved apparatus attached thereto. Fig. 2 shows the arrangement of the air-brake pipes with reference to the main reservoir. Fig. 3, in connection with Fig. 2, illustrates the use of the apparatus for signaling. Fig. 4 is an enlarged view of the gauge-index, and Figs. 5 and 6 are enlarged and detached views of the tripping apparatus of Fig. 1.

Like letters of reference indicate like parts in each.

In the steam-power air-brake apparatus heretofore in use a single line of pipe conveys the compressed air from the main reservoir on the locomotive to each brake-cylinder. If this pipe becomes accidentally broken at any point it is, of course, useless for braking purposes from that point to the rear end of the train. For this and other reasons I have devised an apparatus consisting in part of a double line of brake-pipes, which may be co-operative or independently operative in braking at the pleasure of the engineer, and which as a separate device I have included in a separate application.

The improvement herein described relates to the same class of apparatus; and consists in the features of construction and combination, substantially as hereinafter claimed, by which, first, an air-reservoir, auxiliary to or independent of the main reservoir, is combined on each car with the brake-cylinder; second, by means of a cock or cocks, with suitable ports, such additional reservoir, when used as an auxiliary reservoir, is charged with compressed air from one brake-pipe, and the brake-cylinder from the other, such pipes in such use being interchangeable or not, at pleasure; third, and by means of a single cock with suitable ports either brake-pipe may be used for charging the reservoir and the other for operating

BLEED THROUGH POOR COPY

the brakes; fourth, when a car becomes disconnected from the train by accident or otherwise, a port or ports will thereby be opened in a communicating pipe or pipes, by which the air from such auxiliary reservoir will be admitted freely to the brake-cylinder, so as automatically to apply the brakes; and fifth, the conductor and engineer may communicate signals or orders to each other by the use of the brake-pipes and the compressed air.

Some of the functions above specified are performed by the apparatus described in the separate application above mentioned; and hence in such cases I limit myself in this application to the means set forth or their substantial equivalents.

To enable others skilled in the art to make and use my improvement, I will proceed to describe its construction and mode of operation.

The brake-pipes B B^1 extend along under the body of each car A from end to end, and the pipes of one car are coupled to those of the next by the hose and coupling connections described in patent granted to me August 8, 1870, and thereby connection is made with the main reservoir A^1. The brake-cylinder C is of the usual construction. An air-receiver, D, is attached to the bottom of the car A. This receiver should ordinarily be somewhat larger than the brake-cylinder C, and strong enough to sustain a pressure of, say, one hundred pounds per square inch, more or less. It may be used as a reservoir auxiliary to the main reservoir A^1, or as an independent reservoir, one on each car, for storing up the air necessary to apply the brakes. In this latter use I combine with it any known device for compressing air, such as an air-pump, fan-blower, steam-injector, &c.; and if an air-pump it may be worked by an eccentric on one of the car axles A^2 or in other known way. A pipe or air passage then extends directly or indirectly from it to the brake-cylinder C, with a stop-cock device therein, by which the compressed air is admitted at pleasure from such reservoir D to the brake-cylinder, so as to apply the brakes in the usual way. By the means set forth reservoir D is recharged from time to time, as may
1200 be necessary, in order to keep a store or supply of compressed air always on hand and ready for use. But the chief use which I contemplate for this reservoir D is as an auxiliary to the main reservoir A^1. One brake-pipe, B, I use in the ordinary way for conveying compressed air from the main reservoir A^1 to the brake-cylinder C, and the other pipe, B^1, I always keep in open communication with the main reservoir A^1, so that it is always filled with compressed air; but it is immaterial in the construction shown which pipe is used for either purpose. A cross-pipe, B^2 B^3, connects the pipes B B^1, and from their point of junction the pipes b b^1 branch off, one to the brake-cylinder C and the other to the auxiliary reservoir D. At the junction of these pipes in a suitable case, d, I arrange a cock, d^1, having two non-communicating ports, a a^1, such that in one adjustment they will open communication from B^2 to b, and from B^3 to b^1; and in the other adjustment from B^3 to b and from B^2 to b^1. With the adjustment shown the pipe B^1 is to be used as a reservoir pipe for containing compressed air and conveying the

ame to the auxiliary reservoir D, and the other pipe B is the ordi-
iary operating pipe for operating the brakes in the usual way.

It will be seen that by turning the cock d^1 one quarter way round the relation of the pipes B B^1 to the auxiliary reservoir D nd the brake-cylinder C will be reversed, but that the operation therwise will remain the same. I also so construct my apparatus hat when a car leaves the track or becomes uncoupled from the rain the brakes will be automatically applied by means of the ompressed air which is stored up in the reservoir-pipe and the uxiliary reservoir.

For this purpose I connect the pipes B B^1 with each other near he ends of the car by cross-pipes E E^1. In two diagonally-opposite orners of the parallelogram thus formed I make cases e^1 for the hree-way cocks e, though one such cock and case will suffice to perform the function in view. When the cars are running these cocks re both in the position shown at the upper right corner of Fig. 1, so as to leave a free communication through the pipes B B^1. Each ock e is provided with a handle or arm, which (by means hereinafter described) is, when a coupling breaks or a car leaves the track, shifted so as to throw the cock to the position shown at the lower left-hand corner of Fig. 1, by which through communication is closed and the compressed air passes from the reservoir-pipe B^1 and auxiliary reservoir D around through the operating-pipe B and pipes B^2 b to the brake-cylinder C, and applies the brakes.

To give the cocks e this throw I have shown two devices, which are illustrated in Figs. 1, 5, and 6. In Fig. 6, e^1 represents the cock-case; e^2, the stem of the cock e; and e^3, the shifting-handle, which, in this figure, is in the position it occupies when through communication is open. From a wrist on this handle e^3 a crank-arm, m, extends back to, and, by a catch m^1, engages, a counter-catch, o. A spring, m^2, or its equivalent, a weight, is arranged in connection with the crank-arm m, so that when the catch is released the arm will, by a forward throw, shift the position of the cock e, as above indicated. To effect this release I introduce under the arm m a tripping-head or lever, i, preferably of circular form, so that it will bear against the arm m whichever way it is moved, and from at or about its central point a tripping-stem, i^1, extends downward such distance that when the car is on the track, it will clear the ground, but when the car leaves the track, it will strike the ground, the track, or ties, and, by a vertical, forward, or back or side motion, lift the arm m and disengage the catch with the result already stated. But to shift the position of the cock when the car-couplings break, while the car is still on the track, I run a cord or chain, y, or equivalent device from the outer end of the handle e^3 forward and attach it to the hose-coupling y^1 of that or the next car at such point forward of the "slack" that when the car-couplings break and the slack-hose is straightened out the handle e^3 will by the cord y, be drawn over far enough to shift the position of the cock e, as already explained. In this way the brakes are automatically applied, in case of accident, to any part of the train. The same wire or chain y, or another, may extend in like manner from the coup-

ling y^1 to the stem i^1, or to any other device which will disengage the catch m^1 o with like result to that already stated. A slot, x, is made in the forward or outer end of the arm m, in which the wrist of the handle e^3 plays, in order that the cock may be shifted by the wire y independently of the arm m. But other devices for automatically shifting the cock e may be employed; my present invention not being limited to those described. To the main reservoir A^1 is attached any suitable form of pressure-gauge, as shown at f, and to each brake-pipe B B^1 I attach a pressure-gauge of like suitable form g g^1, and arrange in convenient proximity to each an alarm-whistle h h^1. These gauges g g^1 and whistles h h^1 are for use in signaling. Each one has a graduated index (illustrated in Fig. 4) so constructed, with reference to the pressure of air in the pipes, that a certain amount or degree of pressure—say one-half pound per square inch—shall send the index finger s to the graduation 2; a pressure a little greater, to 3; and so on. By a system agreed on, each graduation indicates a separate order or message, as "flag station," "stop for orders," "danger—run slow," "danger—stop," &c.; the highest or last graduation, preferably, indicating "stop." The gauge is so constructed that greater degrees of air pressure will not affect it. In each car a like gauge is arranged, as shown at g^2, Fig. 3, and a pipe connection, n, n^1, extends from it to the brake-pipes B B^1. This gauge is arranged at any suitable point in the car, and its pipe connections are fitted with a cock,
1201–1203 n^2, which is accessible to the conductor, and of which he carries the key. These pipe connections n n^1 and cock n^2 are such that, on the cock n^2 being opened, the compressed air will be admitted from the reservoir-pipe (say B^1) both to the gauge g^2 and to the other or operating-pipe B, along which it will pass to the gauge g in the engineer's cab. The conductor opens the cock n^2 till the pressure of air has moved the index finger s to the graduation which indicates the order he wishes to give the engineer, and then closes it. The index finger on the engineer's gauge will, in like manner, be carried to the same graduation, and the alarm of the whistle will call his attention to it. By reversing the operation the engineer may communicate messages to the conductor.

I do not deem it necessary to describe more minutely the ports and passages leading from the pipes n n^1 to the gauge g^2, as a suitable arrangement of such devices, on the function being known, can be readily made by those skilled in the art. Where one of the brake-pipes is always used as a reservoir-pipe, and the other as an operating-pipe, only one of the gauges g g^1 will be required, and, of course, it should be arranged on the operating-pipe.

It will be seen that the conductor, by fully opening the cock, in case of extreme danger, will be enabled to apply the brakes himself, as well as notify the engineer, since the air will flow over by the pipes n n^1 from the reservoir-pipe B^1 to the operating-pipe B, and thence to the brake-cylinders. Also, that if it be desired to communicate but a single order, the gauges g g^1 g^2 may be dispensed with, and the order be communicated by a whistle blast.

What I claim as my invention, and desire to secure by letters patent, is—

1. An air-reservoir arranged on each separate car in combination with an air-brake cylinder, D, and main reservoir A^1 on or near the locomotive, substantially as and for the uses set forth.

2. The combination of the pipes B B^1 B^2 B^3 b b^1 with a suitable arrangement of ports for admitting air to the auxiliary reservoir D and brake-cylinder C, substantially as and for the uses set forth.

3. The cock d^1 having ports a a^1, and arranged relatively to the air-reservoir D, brake-cylinder C, and pipes B B^1, substantially as described.

4. A cock, e, arranged in an air-brake pipe, with a suitable arrangement of ports inside and an automatically-operating connection outside, whereby, in case of accident, a free communication will be opened from an auxiliary reservoir, C, to a brake-cylinder, D, and external communication be closed, substantially as set forth.

5. In combination with a pair of air-brake pipes, B B^1, a signaling apparatus consisting essentially of an alarm or index gauge, or both, on or near the engineer's cab, a pipe connection on or in one or more of the cars, from one pipe, B, to the other, B^1, and like means in connection therewith for regulating or fixing the alarm to be given, substantially as set forth.

In testimony whereof I, the said George Westinghouse, Jr., have hereunto set my hand.

GEO. WESTINGHOUSE, JR.

Witnesses:
JOHN H. JOHNSON.
G. H. CHRISTY.

BLEED THROUGH POOR COPY

1205 UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., of Pittsburg, Pennsylvania.

Improvement in Valve Devices for Fluid-brakes.

Specification forming part of Letters Patent No. 141,685, dated August 12, 1873; application filed May 24, 1873.

To all whom it may concern:

Be it known that I, George Westinghouse, Jr., of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful improvement in valve device for fluid-brakes; and I do hereby declare the following to be a full, clear, and exact description thereof, reference being had to the accompanying drawing, which represents in section my improved valve device, designed to be used in connection with a system of brake-pipes, brake-cylinder, and auxiliary reservoir, for the purpose of applying the brakes on railway trains by means of fluid-pressure.

In the system of steam-power air-brakes heretofore described in various patents, provision is made for the flow of air or other fluid under pressure from the brake pipe or pipes into a reservoir arranged under or in connection with each car, and for applying brakes by allowing the compressed air thus stored up in each reservoir to pass into the brake-cylinder. In such combination a triple valve has been described of such construction and with such connections that, by a continuous pressure of air in the brake-pipe, communication was kept open thence to each reservoir and closed to the brake-cylinder, but kept open from the latter to the external atmosphere; and, also, by lowering the pressure of air in the brake-pipe, communication was opened from each reservoir to the brake-cylinder of the car, and all other communication closed.

My present invention relates to an improved construction of triple valve, by means of which this operation is more advantageously effected, and has more particular reference to the construction of devices by which a flow of compressed air from each auxiliary reservoir to its brake-cylinder can be regulated at pleasure, and thereby the brakes be applied with any desired degree of force less than the maximum.

To enable others skilled in the art to make and use my improvement, I will proceed to describe the same.

(Here follows diagram marked p. 1204.)

The valve-case G is of the form substantially as shown, so as to give a valve-chamber, G^1, into which at or near one end a port, G^2, opens, and at or near its opposite end a like port, G^3, also opens. The same valve-case includes also a valve-chamber, H, with a communicating passage, B, and the air-port H′ communicates with the valve-chamber H. The valve-stem *g* has a limited range of motion

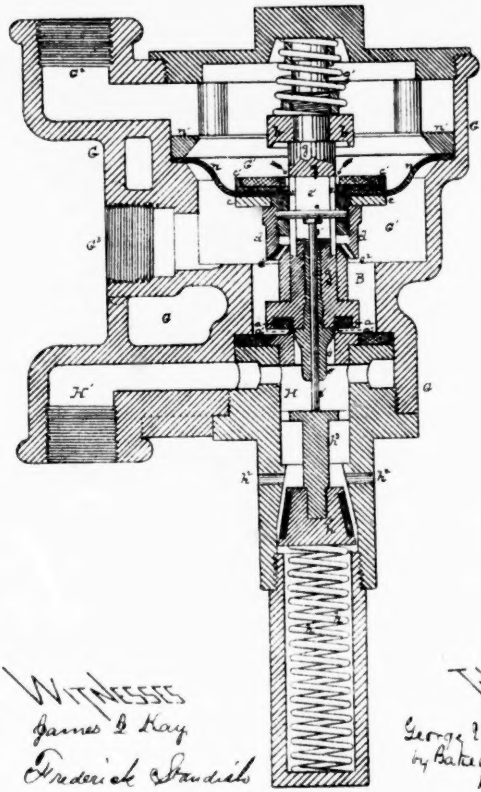
6962

Nos. 403 & 426.
Westinghouse Co } p. 1204
Boyden Co.

G. WESTINGHOUSE, Jr.

Valve Devices for Fluid-Brakes.

No. 141,685. Patented August 12, 1873.



WITNESSES
James L. Kay
Frederick Standish

INVENTOR
George Westinghouse Jr
by Bakewell, Christy & Kerr,
his attys.

BLEED THROUGH POOR COPY

in the chamber G^1. At or near its lower end it carries a valve, *a*, which seats on the annular V-shaped seat *a'* by suitable packing on its lower face. A spring, *g'*, bearing against the cap of the valve-case G, and against the upper face of the valve-seat *b*, holds the lower valve *a* to its seat, when not raised therefrom by air-pressure. The flexible diaphragm *n* divides the valve-chamber G^1 into two parts. The outer edge of this diaphragm or ring *n* is compressed between an annular metallic ring, *n'*, and a shoulder on the valve-case; and the inner edge of said ring around the stem *g* is compressed between the different parts of the compound nut *c c'*, which nut is free to move vertically on the stem *g*, and the upper face *c'* of which is provided with a suitable packing, so as to make a tight joint when brought against the annular ring of the valve-seat *b*. Commencing at a point a short distance below the upper valve seat *b*, the stem *g* is turned smaller or reduced in size, as at *e*, and is also slotted, as indicated at e^1. This reduction in the size of the stem *g* gives an annular air-port, *e*, by which communication is secured from the upper to the lower part of the valve-chamber G^1. The compound nut *c c'*, which constitutes mechanically a piston, has a downward extension around the stem *g*, as shown at *d*, by means of which, in moving up and down on the stem *g*, it covers and uncovers the port *e*, and thereby closes and opens communication between the upper and lower parts of the valve-chamber G^1. The lower end of the annular port *e* communicates with the lower part of the valve-chamber G^1 by means of ports e^2, which may be made in any desired number. Across the slot e^1 in the stem *g* a cross-bar, *s*, is arranged, with its ends fixed in position in the adjacent walls of the nut *c*. From this slotted part e^1 a pin, *s'*, extends down through and lengthwise of the stem *g* into the chamber H. The lower end of the chamber H is fitted with a spring, *h*, which
1206 bears against the conical valve h^1, having a suitable packing on its conical face. Such valve is arranged in its chamber so as to open and close the escape-ports h^2. This valve is attached to a stem, h^3, which, by means of wings of the usual form, causes the valve h^1 to move vertically in its chamber in opening and closing the ports h^2. The pin *s'* is of such length and position that with the downward movement of the piston *c c'* the cross-bar *s* will be caused to bear against its upper end and force its lower end against the stem h^3 of the valve h^1, and thereby throw it from its seat and uncover the ports h^2. The conical plug *o* is attached to the lower end of the stem *g* in such position as to enter the port *o'*, which connects the chambers G^1 and H; but this plug *o* is of such shape as to graduate the size of the opening of the port *o'*, accordingly as it is raised more or less by the upward movement of the stem *g*. The valve-case described is, by the port G^2, connected with the brake-pipes, by the port G^3 with the auxiliary reservoir, and by the port H' with the brake-cylinder. If air or other gas or fluid under pressure be admitted by the port G^2, it will cause the piston *c c'*, with its diaphragm *n*, to be depressed or to slide down on the stem *g* until it occupies about the position shown. The cross-bar *s* will then have opened the valve h^1, and the valve *a* will be

closed by means of the spring g', or by fluid-pressure; also, the annular port e will open. In such case the air or other fluid will pass, as indicated by the arrows, from the upper part of the chamber G^1, along the ports e e^2, into the lower part of the chamber G^1, and out at the port G^3 to the auxiliary reservoir, whereby the auxiliary reservoir will be charged with compressed air of such density as it may be desired to store up for the purpose of operating the brakes. At the same time, by the means already described, the valve h^1 is unseated, and thus a direct communication is opened from the brake-cylinder, through the port H', chamber H, and ports h^2, with the external atmosphere. The brakes are then off. As soon as the pressure on the upper and lower sides of the diaphragm n and compound nut c c' is equal, or nearly so, the spring h in the lower part of the case, acting against the valve h^1 through the stem h^3, pin s', cross-bar s, will cause the piston c c' to slide upward on the stem g, and thereby cut off communication through the annular passage e, and will seat the valve h^1 so as to close the escape-ports h^2. Then, if the pressure above the diaphragm n be reduced by allowing a portion of the air to escape from the brake-pipes, the pressure of the air or other gas, acting back through the port G^3 on the under side of the diaphragm n, will raise the piston c c' against the valve-seat b, compress the spring g', and, by raising the stem g vertically upward, will lift the valve a from its seat a' and thereby open communication from the chamber G^1, through the port o, chamber H, with the port H'. The compressed air or other gas or fluid will then be free to pass from the auxiliary reservoir, through the ports G^3, o', and H', to the brake-cylinder, so as to charge the same and apply the brakes in the usual way. The area of the opening through the port o' is regulated by the distance which the plug o is caused to move vertically upward. Hence, if the pressure be reduced but slightly at G^2, the plug o will be raised but a short distance, and a small amount of compressed air or other fluid will be allowed to pass through and out at the port H'. When the equilibrium is thereby restored in the chamber G^1, the valve a will resume its seat and close the communication. If the pressure in the upper part of the chamber G^1 be materially increased, the lower valve h^1 will be unseated, as already described, and an open communication be made from the brake-cylinder, through the port H' and h^2, to the external atmosphere. By the use of the taper plug o, in the manner described, and by regulating, as can easily be done by the use of suitable cocks, the amount of pressure in the upper and lower parts of the chamber G^1, it is easy to regulate the amount or density of the air which is permitted to flow through the port o' into the brake-cylinder, and consequently easy to regulate and adjust, at all times, the force with which the brakes are applied, and such force may be varied from the maximum power of the brakes down to the fractional part of a pound, in excess of ordinary atmospheric pressure.

The construction of the piston may be varied somewhat, provided its operation and function remain substantially unchanged.

What I claim as my invention, and desire to secure by letters patent, is—

1. The piston $c\ c'$, having separate and independently-operating connections to, and in combination with, a charging-valve, a, and discharging-valve h^1, whereby the discharging-valve shall be closed at or before the opening of the charging-valve, substantially as set forth.

2. The pin s', cross-bar s, and stem g, in combination with the piston $c\ c'$, valves a and h^1, and plug o, arranged substantially as set forth.

In testimony whereof I, the said George Westinghouse, Jr., have hereunto set my hand.

GEORGE WESTINGHOUSE, JR.

Witnesses:

T. B. KERR.

G. H. CHRISTY.

1211 UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., of Pittsburg, Pennsylvania.

Improvement in Steam and Air Brakes.

Specification forming part of Letters Patent No. 144,006, dated October 28, 1873; application filed July 24, 1873.

To all whom it may concern:

Be it known that I, George Westinghouse, Jr., of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful improvement in steam and air brakes; and I do hereby declare the following to be a full, clear, and exact description thereof, which, taken in connection with the accompanying sheets of drawings hereinafter referred to, forms a full and exact specification of the same, wherein I have set forth the nature and principles of my said improvement, by which my invention may be distinguished from others of a similar class, together with such parts as I claim and desire to secure by letters patent—that is to say:

In the specifications of patents obtained by me March 5, 1872, Nos. 122,404 and 122,405, and August 8, 1871, No. 117,841, were described various arrangements and constructions of pipes, valves, and apparatus, whereby compressed air could be made to operate brakes and communicate signals in a railway-train.

My present invention relates to an improved construction of the valves and pipe couplings employed in such apparatus.

(Here follow diagrams marked pp. 1208 & 1210.)

I will first describe my improved construction of valves, referring to figure 1, which represents a section of the valve-box. This valve-box has three chambers or compartments, and is provided with three valves, A, B, and C, united by one stem. The first or upper chamber communicates, by the end passage E, with the pipe by which compressed air is conveyed throughout the train, and, by the side passage F, with the auxiliary reservoir of compressed air. In this chamber there are two valves, A and B, on the same stem of which the upper valve, A, has a greater area than the lower valve, B, and has holes through it near its periphery covered by a disk, *a*, pressed against its back by a spring. The second chamber communicates, by a side passage, G, with the brake-cylinder, and the third chamber has an opening, H, to the atmosphere. This third chamber contains the third valve, C, also on the same stem, which can close upward against a caoutchouc or leather seating, *c*, when the valve A is closed against its upper seat. The seating *c* is made with a little space between its inner edge and the body of the valve-box, so that when the valve C bears against it the pressure of

Nos. 403. 1426
~~Westinghouse Co~~ } p. 1208
Boydin Co.

2 Sheets--Sheet 1.

G. WESTINGHOUSE, Jr.

Steam and Air-Brakes.

No. 144,006. Patented Oct. [illegible], 1873.

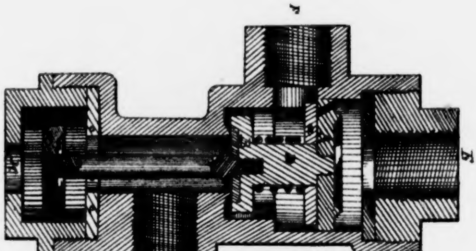


FIG. I.

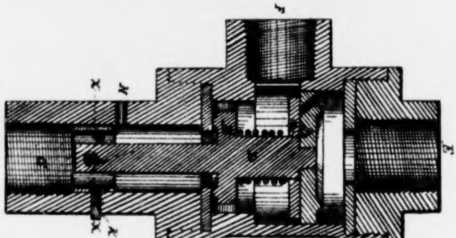


FIG. II.

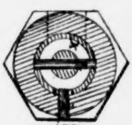


FIG. III.

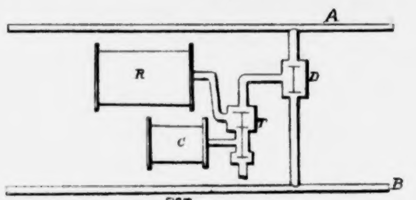


FIG. IV.

Witnesses.

R. E. Whitenshall
J. Isaac Kay

Inventor

George Westinghouse Jr.
by Bakewell, Christy & Kerr
his atty's

No. 403 & 426
Westinghouse Co
v.
Boyden &c
} p 1210

2 Sheets--Sheet 2.

G. WESTINGHOUSE, Jr.

Steam and Air-Brakes.

No. 144,006.

Patented Oct. 28, 1873.

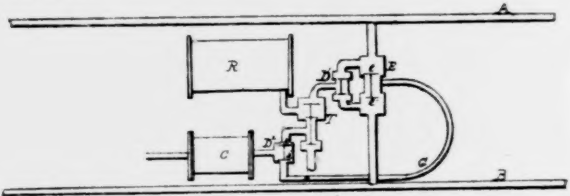


FIG V.

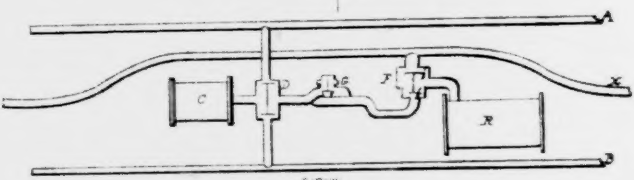


FIG VIII

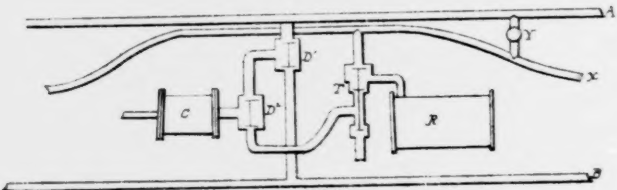


FIG VII

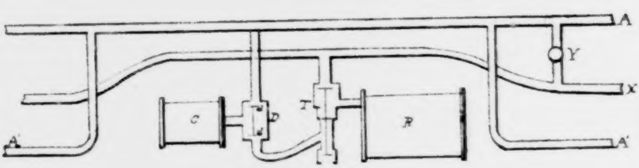


FIG VI

Witnesses

Inventor.

James S. Kay

George Westinghouse Jr
by Bakewell, Christy & Kerr
his Att'ys

air a
of th
Th
auxi
pres
and,
the
hole
and,
At t
B, is
G, p
so th
cylin
If
fron
auto
ferro
whe
iliar
scril
actin
the
that
air-p
and
aux
pass
to p
T
pipe
aux
whe
the
F

121

is b
F
acts
A is
B is
T
an a
fits,
the
stem
The
to F
I

B

ove the seating shall press it against the raised annular edge valve C, and thereby insure the tightness of its closure.

operation of these valves is as follows: Assuming that the ary reservoir is not charged with compressed air, when com-d air is admitted into the air-pipe it enters by the passage E, ts pressure acting on the larger valve A, opens it and closes lve B. The compressed air thus admitted flows through the in the valve A, pressing away the disk *a* that covers them, y the passage F, to the auxiliary reservoir, which it charges. same time the valve C, being on the same stem with A and pened, and air from the brake-cylinder issues, by the passage t the valve C and through the opening H to the atmosphere; t the brakes are taken off by relieving the piston in the brake-ler from pressure.

ow it be required to put on the brakes, air is allowed to escape the air-pipe, either by opening a cock or valve by hand or atically, (in the manner described in the specifications re-to above,) when the air-pipe or its connections give way, or a carriage becomes detached or runs off the line. The aux-reservoir having been charged with compressed air, as de-d above, the pressure communicated through the passage F on the larger area of the valve A, and finding no escape by oles in its periphery, which are closed by the disk *a*, raises alve against its seat, and so closes communication with the pe by the passage E. At the same time the valve B is opened, he valve C is closed. Compressed air then flows from the ary reservoir by the passage F, past the valve B, through the ge G to the brake-cylinder, where it acts on the piston so as on the brakes.

ıs, by means of this triple-valve arrangement, when the air-communicating with E are charged with compressed air the ary reservoirs are charged and the brakes are taken off, and air is discharged from the air-pipes, the brakes are put on by tion of the air stored in the auxiliary reservoir.

. 2 represents a section of a construction of such a valve-box in which the lower disk-valve C is replaced by a sliding-ring valve, K. In this case the opening to the atmosphere is a side passage, H, and the communication to the brake-cylinder the end passage G.

. 3 represents a sectional plan on the line X X. The ring K s circular slide, which closes the opening H when the valve eated, and leaves it open, as shown in Fig. 2, when the valve eated.

ring is divided at one side to allow it to spring so as to make -tight fit in the cylindrical part of the valve-box in which it nd a steady-pin, *k*, projecting into the slit of division prevents ng from turning round. The ring is connected to the valve-by a pin, *l*, passing through the sides of the ring and the stem. ction is in this case the same as that described with reference . 1.

ave described the action of this valve arrangement as if it

EED. THROUGH POOR COPY

communicated with only one air-pipe. By combining it, however, with double valves connected by a stem, such as have been described in the specifications above referred to, either or both of the duplicate air-pipes serve to work upon the auxiliary reservoir and brake-cylinder, as above described.

By referring to the before-mentioned specifications it will be seen that these double valves are of two kinds, one which opens the passage from the pipe of higher pressure and closes the passage to the pipe of lower pressure, and the other which closes the passage from the pipe of higher pressure and opens that to the pipe of lower pressure.

In connecting the duplicate air-pipe with the valve-box above described, and with the brake-cylinder, such double valves may be arranged in the manner shown in the diagram plan, Fig. 4. In this diagram A and B represent the two air-pipes, communicating throughout a train; R, the auxiliary reservoir; and C the brake-cylinder. T is the triple-valve arrangement, above described, and D is one of the double-valve arrangements described in the specification above referred to, whereby either of the pipes A or B, that contains air at lower pressure than the other, is cut off. It will be seen that compressed air conveyed along either or both of the pipes A and B will operate on the auxiliary reservoir R and the brake-cylinder C by means of the triple-valve arrangement T, in the manner above described.

Sometimes it is desirable that either of the two communicating air-pipes may be employed to charge the reservoir, while the other pipe may be used to operate the brakes. An arrangement of valves for this purpose is shown in the diagrammatic plan, Fig. 5, where A and B represent the two air-pipes; C, the brake-cylinder; R, the auxiliary reservoir; T, the triple-valve arrangement, above described; D^1 and D^2, double valves, such as that marked D in Fig. 4; and E, one of the other kind of double-valve arrangements, described in the former specification referred to above, whereby the pipe containing air at higher pressure is cut off from communication.

From this arrangement it will be seen that one of the pipes—such as A—may be employed to charge the reservoir R, the compressed air from A passing by the one end of E, and past one of the valves in D^1, acting on the large valve in T, so as to open it and the farthest valve, and close the middle valve of T, and passing the larger valve of T to the reservoir R. At the same time the other pipe, B, may be charged with compressed air for putting on the brakes, the air from that pipe passing the open valve e', and thence by the pipe G to the valve-box D^2, where it will open the valve d' and close d, and thence to the brake-cylinders C, where the pressure will act on the piston so as to put on the brakes. If, now, the pipe B be relieved of pressure, then, the valve e being closed and e' being open, the air in the pipe G will have its pressure reduced. The valves d d' will then be in equilibrium, allowing the air from the brake-cylinder to escape past either or both of them, and either past the third valve in T to the atmosphere, or by the pipe G and past

the valve e' to the discharge-pipe B. Again, assuming the reservoir R to have been charged with compressed air, and the pipe B to be relieved of pressure, by relieving the other pipe A of pressure the brakes will be put on, for the valves in E and D^1 being then in equilibrium the pressure is taken off the large valve in T, which is therefore closed, opening the second valve in T and closing the third, so that compressed air will flow from R past the open valve in T, and opening the valve d and closing d' into the brake-cylinder C.

Two pipes communicating throughout a train may be applied in connection with valves in the manner represented on the diagram plan, Fig. 6. Here the one air-pipe A is shown with branches A′ at each end of the carriage for convenience of coupling, as has already been described by me in the former specifications referred to. The other pipe, X, communicates with the triple-valve arrangement T. Assuming that X is charged with compressed air, it charges the auxiliary reservoir R, keeping open the large valve in T and the third valve, and closing the middle valve. Then compressed air admitted into the pipe A will open the valve d and close d', and pass into the brake-cylinder C, so as to put on the brakes; and when air is discharged from A, the valves d and d' being in equilibrium, the air from C will pass either d into the pipe A or d' past the third valve in T to the atmosphere, and thus the brakes will be taken off. Again, the pipe A being relieved of pressure the brakes can be put on by discharging air from the pipe X, for then the larger valve in T and the third valve will be closed, and the middle valve will be opened, so that compressed air will flow from the reservoir R past the valve d' to the brake-cylinder C. The air can be discharged from X, either by a cock or valve opening, directly to the atmosphere, or by a cock, Y, in a branch connecting X with A.

In this case the air admitted from X to A may serve for sig-
1213 naling by sounding-whistles or working-gages connected to
the pipe A in the manner described in former specifications referred to. Instead of one pipe, A, with branches A′, as shown in Fig. 6, two pipes A and B, with a third pipe, X, may be employed, as shown in the diagram plan, Fig. 7. Here it will be seen that either of the pipes A or B can be employed to work the brakes, while X, when charged, is employed to charge the reservoir R, and when discharged to permit the air stored in the reservoir to work the brakes. The contents of the pipe X may be discharged into the atmosphere by a cock or valve, or into one of the other pipes, as A, by means of a branch provided with a cock or valve, the pipe A being thus rendered available for communicating signals. The three pipes A, B, and X may be employed with a combination of valves such as is shown in the diagram plan, Fig. 8, where F represents a double-valve arrangement, such as was described in previous specifications referred to, having the upper valve f of larger area than the lower valve f'. D is a double-valve arrangement like that described above and marked with the same letter, and G is a check-valve of any known description. It will be seen that the reservoir R can be charged from the pipe X, the valve f being opened and f' closed by the pressure of the air in the pipe X. At the same time

the brakes can be put on by charging either or both of the pipes A or B with compressed air, and taken off by discharging the air fron both. Again, if the pipes A and B be closed, and air be discharge from X, the air stored in the reservoir R closes the valve *f*, opens *f'* and passes G to the brake-cylinder C, so as to put on the brakes, an also to charge the pipes A and B for communicating signals. I this case the check-valve G performs the function of the third valv C above described, and in such construction is the mechanical equivalent therefor, the valves *f f'* corresponding in function and structur to the two upper valves of Fig. 1.

It will readily be understood that the several kinds of valv arrangements described in this and in the former specifications referred to can be combined in many other ways, so as to effect th working of brakes and communication of signals according to various systems of operation.

The arrangements shown in the diagrams, Figs. 4, 5, 6, 7 and 8, described above, are given as examples of how such combination of valves may be made, and although in these, for the sake of distinctness, the several valves are shown as if they were fitted in separate chambers, it may be readily understood that they might be fitted into separate compartments of one valve-box, so as to secure greater simplicity and compactness of construction. The same features of construction and combination may be employed in connection with hydraulic gas or other fluid brakes. In connection with hydraulic brakes, an accumulator should take the place of the reservoir.

What I claim as my invention, and desire to secure by letters patent, is—

1. The combination of the triple valve A B C, seated as described, the valve-case connection E, above the valve A, to an air-supply pipe, a connection, F, between the valves A B with an auxiliary reservoir, a connection, G, below the valve B, with the brake-cylinder, substantially as set forth.

2. A triple valve arranged, in combination with a line of brake-pipe, auxiliary reservoir, and brake-cylinder, so that by the introduction of compressed air or steam the auxiliary reservoir will be charged and the brakes let off, and when the air is let off from such pipes an opening will be made from the auxiliary reservoir to the brake-cylinder, substantially as set forth.

In testimony whereof I, the said George Westinghouse, Jr., have hereunto set my hand.

GEORGE WESTINGHOUSE, JR.

Witnesses:
JOHN H. BAILEY.
G. H. CHRISTY.

2 Sheets--Sheet 1.

W. D. JONES.

Air-Brakes.

No. 166,386.

Patented Aug. 3, 1875.

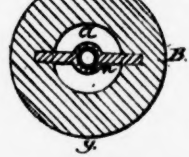


Fig. 3.

Fig. 1.

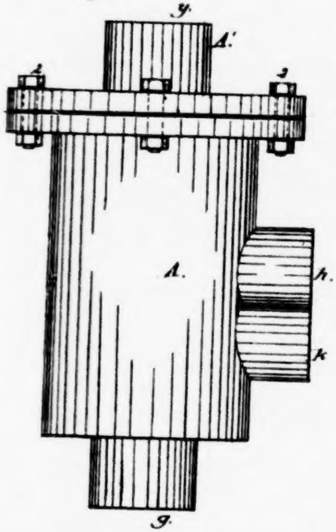
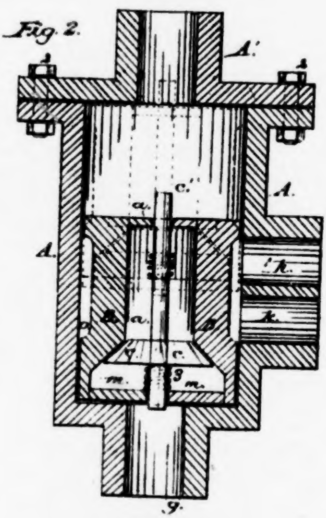
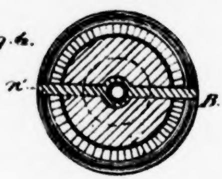


Fig. 2.



No. 403 & 426.
Westinghouse Co. v. Boyden Co. } p. 1216.

Fig. 4.



Witnesses:

[signature] Rawlings

Henry E. Greene

Inventor:

W. Davidson Jones

2 Sheets--Sheet 2.

W. D. JONES.

Air-Brakes.

No. 166,386.

Patented Aug. 3, 1875.

Fig. 5.

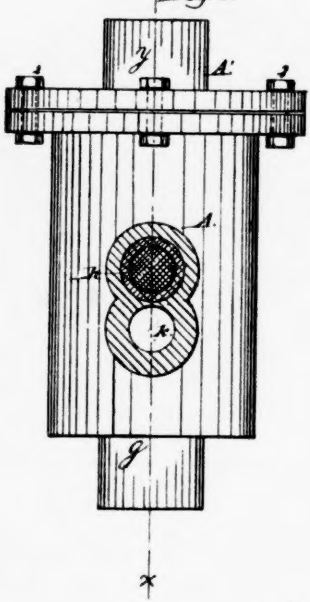
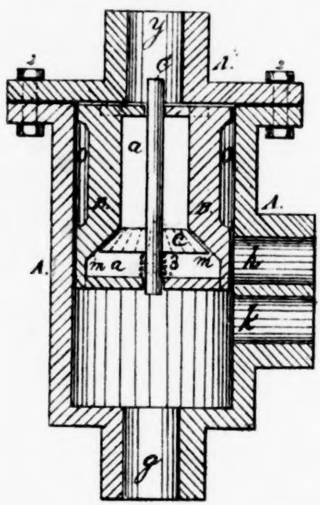


Fig. 6.



No. 4030426.
Westinghouse 6 } p. 1218
Boyden 6.

Witnesses:
Wm M Rawlings
Henry E. Greene

Inventor:
W. Davidson Jones

1219 UNITED STATES PATENT OFFICE.

W. DAVIDSON JONES, of Hagaman's Mills, New York.

Improvement in Air-brakes.

Specification forming part of Letters Patent No. 166,386, dated August 3, 1875; application filed July 27, 1875.

To all whom it may concern:

Be it known that I, W. Davidson Jones, of Hagaman's Mills, in the county of Montgomery and State of New York, have invented a new and useful improvement in automatic-supply relief-valves for operating compressed air-brake cylinders; and I do hereby declare the following to be a full, clear, and exact description thereof, reference being had to the accompanying drawings, making part of this specification, in which—

(Here follow diagrams marked pp. 1216 & 1218.)

Figure 1 is a side elevation of the valve. Figs. 2 and 6 are sectional views of Fig. 1, on the plane of the line *x x* in Fig. 5, showing the induction and eduction ports, the compound trunk-valve B B, and valve *c* on the stem *c'*, held to its seat *m m* by springs 3 3. Fig. 3 is a transverse section of the end of trunk-valve B B, showing the passage *a* and valve-stem guide *n*. Fig. 4 is a transverse sectional view of the opposite end of the compound trunk-valve B B, showing the valve *c* and valve-stem guide *n'*. Fig. 5 is an elevation of the valve, looking at the ports *h* and *k*.

Like letters and figures of reference indicate like parts in each drawing or figure.

My invention relates to that class of compressed air-actuated car-brakes in which the air is conveyed back to reservoirs beneath each car by a pipe from a main reservoir on the engine, the compressed air from the auxiliary reservoirs on each car of the train operating a movable piston within a cylinder, thereby applying the brake-blocks to the wheels, as is commonly done. By the interposing of my invention in close connection therewith, and between or by its use forming the connections between the auxiliary reservoir, the cylinder containing the piston, and the branch-pipe from the main supply-pipe, the brakes may be rapidly and readily applied, and as rapidly and readily released, at the will of the engineer, or automatically set on all the cars of the train, should the cars become uncoupled, or the main supply or branch pipes become broken, as will be hereinafter fully set forth.

My improved automatic-supply relief-valve for connecting the branch induction-pipe with the auxiliary reservoir, and at the same time closing connections with the brake-cylinder, and at the will of the engineer (or in case of accident uncoupling of cars, or rupture of main pipe from the reservoir on the engine or tender) to close

such connections, and to automatically open connections between the auxiliary reservoir and the brake-cylinder, thereby allowing the compressed air to pass to said cylinder, actuating the piston thereof and applying the brakes, as is usually done, and as readily relieving the cylinder of the compressed air, and discharging it by opening communication from the cylinder with the atmosphere, and at the same time restoring the connection between the main supply-pipe and auxiliary reservoir by decreasing and increasing the pressure in the main supply-pipe running the whole length of the train.

My invention may be used to operate the pistons of brake-cylinders attached to each car where there is no auxiliary reservoir employed, and discharge the compressed air directly from the cylinder, after doing its work, into the atmosphere, without returning it to the engine through the supply-pipe, the same being done by simply cutting off the supply or pressure from the main supply-pipe.

To enable others skilled in the art to make and use my invention, I will proceed to describe its construction and operation.

A is a valve-case, made substantially as shown, and provided with a cap, A′, containing the induction port or passage *y*, said port connecting with the main supply-pipe from the engine, and being also provided with eduction pipe or port *g*, to which is connected the auxiliary reservoir and eduction-induction port *k* communicating with the brake-cylinder, and eduction-port *h* communicating with the atmosphere. The cap A′ is secured to the shell-case A by bolts 2.

The compound trunk-valve B, Figs. 2 and 6, is made of proper form, substantially as shown, having the circumferential depression *o*, Figs. 2 and 6, and valve-seat *m*, valve *c* on valve-stem *c′*, is held in position by valve-stem guides *n n*, Figs. 3 and 4. Said valve *c* is held to its seat *m*, Figs. 2 and 6, by spiral spring 3.

The operation of my invention is as follows: With the
1220 port *y*, Figs. 1, 2, 5, and 6, connection is made with the supply-pipe leading from the main reserveir on the engine. With the port *g* connection is made with the auxiliary reservoir. With the port *k* connection is made with the brake-cylinder, operating a piston within, and port *h* communicating with the atmosphere.

Compressed air being admitted from the main reservoir attached to the engine, through a three-way cock, into the supply-pipe and its branches to each car of a train, the compound trunk-valve B would be driven by the compressed air to the rear or lower end of the case A, and closing port *k* leading to the brake-cylinder, as shown in Fig. 2, the strength of the spiral spring 3 holding valve *c* to its seat *m* sufficiently firm to carry the compound trunk-valve B to the lower end, as shown in Fig. 2; the pressure would then unseat valve *c* on stem *c′* and allow the air to pass, through port *y*, passage *a*, and port *g*, into the auxiliary reservoir. The pressure in the auxiliary reservoir would be about equal to the pressure in the main reservoir and supply-pipes. The brake-cylinder would communicate with the atmosphere through port *k*, circumferential de-

ression o, and eduction-port h, thereby leaving the piston free to eturn to the back of the cylinder by the action of the throw of prings attached to the brake-blocks, or through any other suitable gency.

When the engineer wishes to put on the brakes he turns the three-vay cock near to him in the supply-pipe, cutting off communication vith the main reservoir and opening communication with the at-nosphere in that portion of the supply-pipe in rear or back of the hree-way cock, thereby reducing the pressure in that portion of the upply-pipe and its branches leading to each automatic-supply elief-valve, which, by the excess of pressure retained in the auxiliary eservoir, would force a current of compressed air backward, closing irmly on its seat the valve c, Figs. 2 and 6, and driving the com-ound trunk-valve B into the forward part of valve-case A, as indi-ated by the dotted or broken lines in Fig. 2, and fully shown in 'ig. 6, thereby opening full and free communication from the aux-liary reservoir, through ports g and k, into the brake-cylinder, hereby moving the piston, and, by suitable connections from said iston to the brake-blocks, applying the brakes.

When the train is stopped and the engineer wishes to take off r release the brakes, he turns the three-way cock so as to close ommunication with the atmosphere and open communication from he main reservoir on the engine with the supply-pipe, and to each utomatic-supply relief-valve, which, by the excess of pressure in he main reservoir and supply-pipe over the reduced pressure of the xpanded air in the auxiliary reservoir and brake-cylinder, causes current of air to pass into the port y, Figs. 2 and 6, and, by the pring 3, holding valve c on its seat m, the compound trunk-valve 3, Figs. 2 and 6, is driven from the position just described and fully hown in Fig. 6 to the position shown in Fig. 2, at the bottom or ack end of the valve-case A, and simultaneously closing port k rom communication with port g, Fig. 2, the compressed air from he supply-pipe unseating valve c and passing into the auxiliary eservoir until the equilibrium is restored, and, with the return of he compound trunk-valve B to the position shown in Fig. 2, com-nunication is opened from the brake-cylinder, through port k, ircumferential depression o on the compound trunk-valve B, and ort h, Fig. 2, with the atmosphere, thereby allowing the air in the rake-cylinder to instantly escape, releasing at once, through the nedium of the piston and connections, the brake-blocks.

It is evident that my invention can be used as a simple relief-alve, without any auxiliary reservoirs, by placing it between the rake-cylinder under each car and the branch-pipe leading from the upply-pipe, and making the following connections, that is, connect-ng the branch-pipe to the induction-port y, Figs. 2 and 6, and the rake-cylinder to port g, plugging port h, as shown in Fig. 5, by ross shading, to prevent dust and like matter from entering, as hat port is not used.

The operation as a simple relief-valve is as follows: When the en-ineer wishes to put on brakes he turns the three-way cock in the upply-pipe, thereby closing communication with the atmosphere

BLEED THROUGH POOR COPY

and opening communication from the reservoir to each car through the supply-pipe and branch to port *y*, Figs. 2 and 6, forcing the trunk-valve B to the back end of the case A, thereby closing eduction-port *k*, as shown in Fig. 2, when the compressed air will unseat valve *c* and pass from the branch-pipe through port *y*, air-passages *a*, and port *g*, into the brake-cylinder, actuating the piston and putting on the brakes.

To release the brakes the engineer turns the three-way cock so as to close communication with the reservoir and open communication with the supply-pipe running back through the train with the atmosphere. As soon as the pressure in the supply-pipe is reduced the back-flow from the brake-cylinder commences, driving the compound trunk-valve B into the forward part of case A, as shown in Fig. 6, and opening communication from the brake-cylinder, through ports *g* and *k*, into the open air, thereby releasing the brake-cylinder piston and, through its connection, the brake-blocks.

The compound trunk-valve B may be packed at each end to prevent the leaking and injury, if so desired, and the valve-seat *m* may also be packed with suitable packing.

This supply relief-valve is automatic in its operation, is durable, and is free from liability to get out of order.

A stop-cock may be placed in the pipes leading from the auxiliary reservoirs to the valve-ports *g* on each car, so as to
1221 & 1222 close the same in case a car is to be removed from the train to prevent the brakes from being set.

The port *h* may be placed on any side of the case A A A′, retaining its position lengthwise, without changing the nature of my invention.

The manner of its use and operation will be readily understood by those skilled in the art.

I am aware that it is not new in air-brakes to use a hollow piston-valve having a supplemental valve working therein, the latter opening against the pressure, and hence I make no claim to the same; but

What I claim, and desire to secure by letters patent, is—

The combination, with the valve-casing having ports *y*, *g*, *h*, and *k*, of the hollow piston-valve and check-valve inclosed therein, to open with the pressure, the ends of the piston-valve having perforated cross-bars to support the stem of the check-valve, substantially as and for the purposes specified.

W. DAVIDSON JONES.

Witnesses:

WM. M. PAWLINGS.
HENRY E. GREENE.

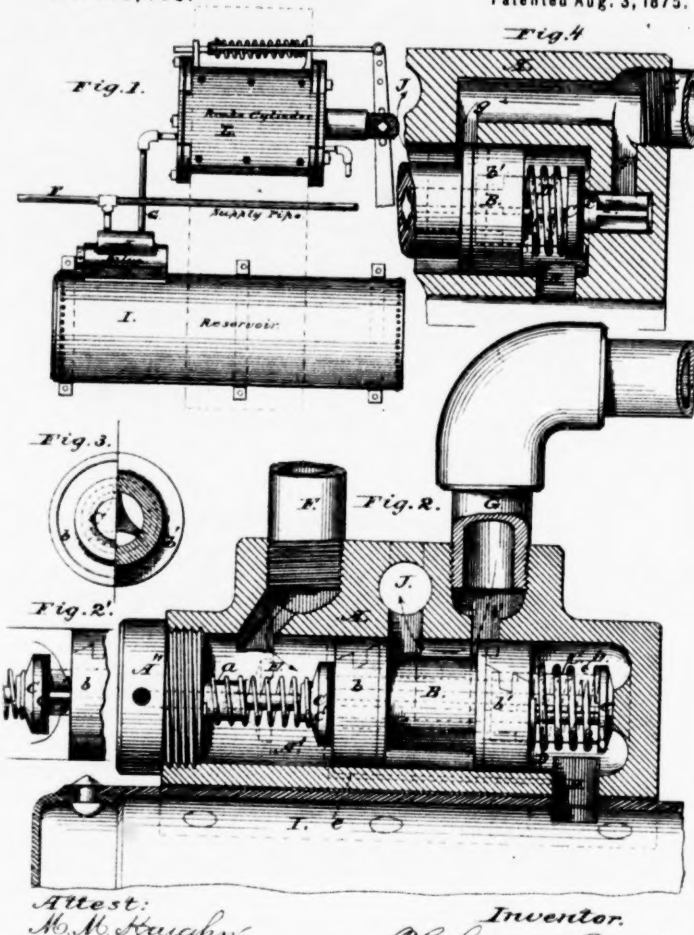
BLEED THROUGH   POOR COPY

No 403 & 426
Westinghouse Co
vs
Boyden Co } p1224

H. L. PERRINE.

Air-Brake.

No. 166,405. Patented Aug. 3, 1875.



Attest:
M. M. Kaughn
Ulysses G. White.

Inventor.
H. Lansing Perrine.

1225 UNITED STATES PATENT OFFICE.

H. LANSING PERRINE, of Freehold, New Jersey.

Improvement in Air-brakes.

Specification forming part of Letters Patent No. 166,405, dated August 3, 1875; application filed July 29, 1875.

To all whom it may concern:

Be it known that I, H. Lansing Perrine, of Freehold, in the county of Monmouth and State of New Jersey, have invented certain new and useful improvements in air-brakes, of which the following is a full, clear, and exact specification:

This invention is in the nature of an improvement in single-acting air-brakes, wherein each car is provided with an air-reservoir and a brake-cylinder, admission of air to both of which is controlled by an intermediately-located valve of peculiar construction, in such manner that, as air is being supplied through the pipes from the main reservoir at the locomotive, communication is open to the reservoir under each car, and cut off from the brake-cylinder, until the pressure in said reservoir equals that in the supply-pipes, when, if the pressure of air in the pipes is slacked or diminished, the valve opens the brake-cylinder inlet, and allows the air in the reservoir to escape into such cylinder and force on the brakes; and the invention consists in a tubular spring piston-valve operating in a chamber or shell having an inlet for the air, a reservoir-opening, and a combined supply and exhaust for the brake-cylinder, as hereinafter fully described.

Referring to the drawings,

(Here follows diagram marked p. 1224.)

Figure 1 is a top or plan view of an air-brake mechanism with my valve attached. Fig. 2 is a partly sectional view of the valve about full size. Fig. 2′ is a side elevation of the front end of the valve open, or in position to allow air to flow into the reservoir. Fig. 3 is an end view of the valve in half-section and half-elevation. Fig. 4 is a sectional view of one end of the valve modified.

L represents a brake-cylinder, and I a reservoir, such as are usually attached to each car. A is a valve secured to or otherwise connected with said reservoir, and with the supply-pipe F, extending from the main reservoir on the locomotive, and further communicating with the brake-cylinder by a pipe, G. Within the casing or shell of valve A I make a chamber, A′, and close its open end by a plug or nut, A″. In this chamber I make openings to receive the supply-pipe F and pipe G, leading to the brake-cylinder; also, an opening, H, leading into the reservoir. B is a valve having a

hollow center, in which a supplemental spring-valve, C, is placed, on which the valve B moves back and forth. The valve B is made in the form of a piston, with two heads, *b b′*, fitted with a peripheral steel or other packing, and connected by a stem of less diameter, and with a central cavity, in which fits the winged valve C. The valve C, near its rear end, is formed with a stop or shoulder, against which the valve B strikes in its backward movement, and is prevented from being forced back too far, whereby it might cover or close the reservoir-port H. This valve C has a packed flange or head, *c′*, for controlling the front of the opening in valve B, and said head is extended into a stem fitting into and guided by a socket, *a*, in the nut A″, and between said head *c′* and nut is arranged on the stem a coiled or other spring, E. The other end of the valve C is made with a head, *c*, between which and the piston B is arranged a coiled or other spring, D. In filling the reservoir air is turned into the supply-pipe, which, entering the valve, presses back the piston B, so as to force it away from the head *c′*, and allow the air to pass through the hollow valve B into the reservoir through opening H. The brake-cylinder port is then, between the heads *b b′*, cut off from communication with the reservoir and supply-pipe, and any air in said cylinder flows back through said pipe, and exhausts at port J. Now, when the pressure of air in the pipe F and reservoir is equalized, the supply may be withheld or withdrawn from said pipes, when the force of spring D, exerted against the valve B, will drive it up against head *c′*, and close said valve. This will carry head *b′* the other side of the brake-cylinder port, and establish communication between the reservoir and said brake-cylinder, and set the brakes. The spring E serves simply to insure an easy and accurate working of the valves B C.

It will be seen that the valves B C combine to make a double-acting valve with relation to the reservoir and cylinder.

When the brakes are to be let off, the air is turned into the pipes F, and the first-described operation repeated, springs or other means being employed to retract the brakes.

1226 The modification illustrated in Fig. 4 shows ports *g g′*, for supplying air to the cylinder. Port *g* is controlled by head *b′*, and port *g′* by a winged plunger, P, working in a recess at right angles to said port, and operated by its connection with valve C. This insures a quick supply to the cylinder, and the spring E can be dispensed with.

Provision for any necessary movement of valve C is made by extending the socket *a*. It may be necessary to make an opening or way, *e*, leading from the reservoir to the front of the valve-casing, in order to insure the equalization of pressure on the piston-valve that may be lacking by reason of leakage in the pipes or elsewhere.

I am aware that it is not new in air-brakes to use a hollow piston-valve having an inclosed check-valve opening with the pressure, and, therefore, I make no claim to the same; but,

Having thus described my invention, what I claim is—

The combination, with the valve-casing, having ports arranged substantially as described, of the hollow piston-valve and a supplemental wing-valve, the latter, when serving to admit air to the reservoir, opening against the pressure, as and for the purpose set forth.

To the above specification of my invention I have signed my name this 29th day of July, A. D. 1875.

H. LANSING PERRINE.

Witnesses:

WM. H. FINCKEL.

A. C. BRADLEY.

1231 UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., of Pittsburg, Pennsylvania.

Improvement in Air-valves for Power-brakes.

Specification forming part of Letters Patent No. 168,359, dated October 5, 1875; application filed August 19, 1875.

To all whom it may concern:

Be it known that I, George Westinghouse, Jr., of Pittsburg, county of Allegheny, State of Pennsylvania, have invented or discovered a new and useful improvement in air-valves for power-brakes; and I do hereby declare the following to be a full, clear, concise, and exact description thereof, reference being had to the accompanying drawing making a part of this specification, in which—like letters indicating like parts—

(Here follow diagrams marked pp. 1228 & 1230.)

Figure 1, sheet 1, is a longitudinal and vertical sectional view of a valve-case, valves, connections, and ports, illustrative of my improvement. Fig. 2, sheet 2, is a transverse section thereof through $x\ x$, Fig. 1. Fig. 3, sheet 1, is a detached sectional view of the cock and connecting-ports; and Fig. 4, sheet 2, illustrates in outline the arrangement of my improved valve device in a system of air-brake apparatus.

My present improvement is particularly designed for use as a part of a system of brake apparatus now generally known as the Westinghouse automatic brake, and consists of certain improvements in the devices by the agency of which the flow of the compressed air, both as to direction and amount to and from the auxiliary air-reservoirs and brake-cylinders, is effected and regulated; and it further consists in the incorporation of suitable devices, by means of which the parts peculiar to the automatic system of operation are thrown out of operation or cut off, so that the brakes shall be set or put on by the direct admission of air from the brake-pipe to the brake-cylinder.

The valve-case D is made of cylindrical form, for the most part, though of different diameters at different points, as shown. It incloses a piston-chamber, a, a valve-chamber, a^1, and a communicating passage, a^2. A screw-cap, D^1, closes its larger end. In the periphery of this cap I cut an annular air-groove, c, from which a series of radial air-ports, c', in any desired number, open into an annular space, a^3, which latter opens directly into the piston-chamber a. This cap has a tubular extension, d, into the outer end of which I screw a stem-guide or bush, d^1. The upper end of the bush affords a bearing for one end of a spiral spring, d^2, which latter, at its opposite end, bears against a collar, d^3, on the stem d^4, so as to hold the stem up when not depressed, as hereinafter described.

1980

Nos. 483 1426
Westinghouse Co } p 1228
Boydia Co

2 Sheets--Sheet 1.

G. WESTINGHOUSE, Jr.

Air-Valve for Power Brakes.

No. 168,359. Patented Oct. 5, 1875.

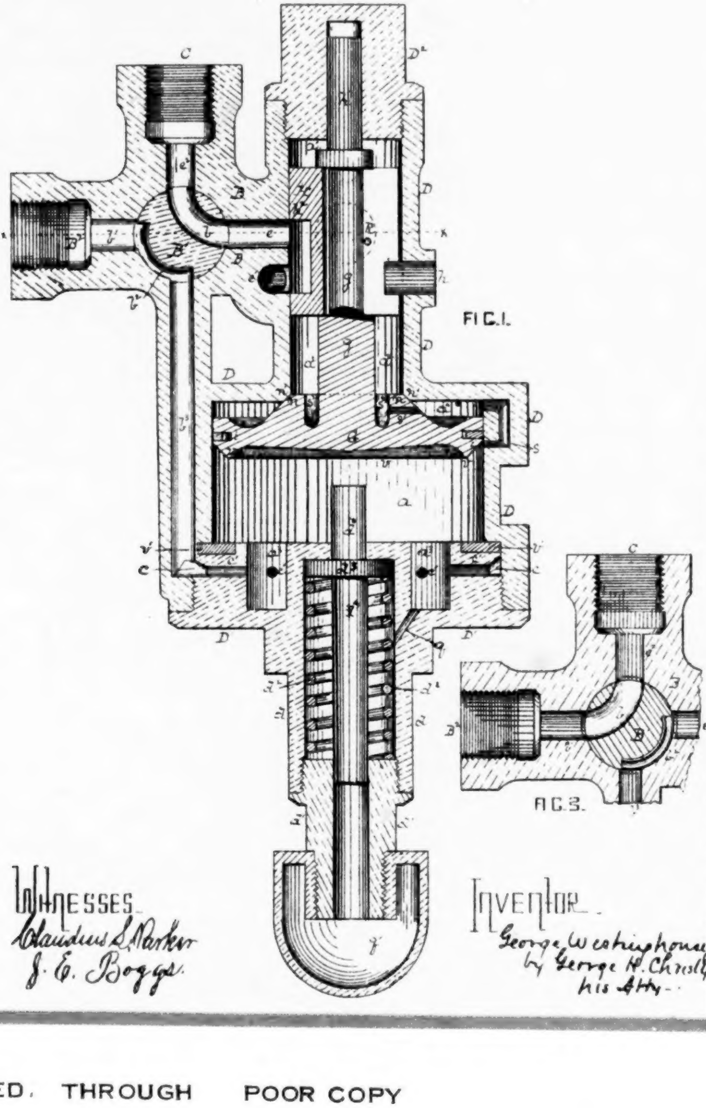


FIG. 1.

FIG. 3.

Witnesses
Claudius L. Parker
J. E. Boggs

Inventor
George Westinghouse
by George H. Christy
his Atty.

BLEED THROUGH POOR COPY

Nos. 403 & 426
Westinghouse Co
v.
Boyden Co
p. 1230

2 Sheets--Sheet 2.

G. WESTINGHOUSE, Jr.

Air-Valve for Power Brakes.

No. 168,359. Patented Oct. 5, 1875

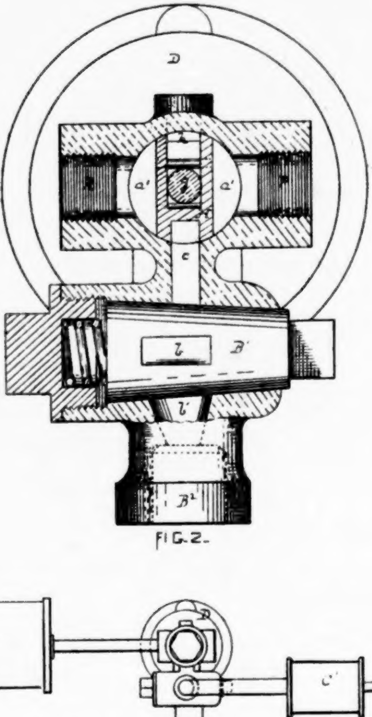


FIG. 2.

FIG. 4.

Witnesses.

Claudius L. Parker
J. E. Boggs.

Inventor

George Westinghouse Jr.
by George H. Christy
his Atty.

BLEED THROUGH POOR COPY

One end of the stem d^4 passes through a suitable aperture in the cap D^1 and enters the piston-chamber a, and the other end is guided in the tubular aperture of the bush d^1.

From the valve-chamber a^1 a side port, R, leads by suitable pipe connections to an auxiliary reservoir, R′, of the usual or any suitable construction. In this chamber is a slide-valve, H, from beneath which a port, e, leads through a bracket-arm, B, in which is formed a cock-case, and through a cock, B′, arranged therein by a port or passage to a coupling, C, from which, by suitable connections, communication is effected with the usual brake-cylinder C′. Another port, e^1, leads from the valve-chamber a^1 to the external air, and these ports e e^1 are in such proximity at their valve-chamber ends that they be brought into communication, or one cut off from the other, by the movement of the valve H. This valve is kept from revolving by means of a pin, h, entering a groove in its back or top, or by other suitable means, and is fitted with any desired known appliances for adapting it the better for its work.

The piston-chamber a contains a piston, G, suitably packed by a leather or metallic ring or rings, i, such as will give a close joint and work with small friction. From its upper side a stem, g, leads to and carries the valve H, and the upper extended end h' of the stem is guided, if need be, in a tubular socket made in the upper cap D^2, which closes the upper end of the case D. Hence the valve H is operated by the piston G. The lower face of the piston has a V-shaped seat, v, which, at the lowest possible point of the downstroke of the piston G, seats on a rubber seat, v'. On the upper side of the piston G I make an annular valve n, and a seat, n', on the case, so that these shall come together and close direct through-communication, or prevent leakage when the piston G is at its highest point of stroke. When in this position, however, it
1232 uncovers a port, s, which is made in the case D, so as to make an open communication from one side of the piston to the other. The air passing through this port then enters the space a^4 above the piston, and thence passes by one or more radial ports, s^1, into the annulus s^2, and thence along the communicating passage a^2, and out by the port R, to the auxiliary reservoir R′.

The introduction of compressed air from the brake-pipe is effected by suitable pipe-connection through the coupling B^2. A port, b^1, leads thence by a groove, b^2, in the face of the plug B^1 to an air-passage, b^3, made along the side of the case D, which passage, b^3, opens into the annular groove c. The plug or cock B^1 is made to revolve in its case or seat, for purposes presently to be explained. The arrangement of its communicating passages being shown, its construction in other respects is such as is well known in the art. The coupling-port shown at P is simply made for convenience, and is to be closed by an ordinary screw-plug.

The devices thus described are arranged on each car with an auxiliary air-reservoir, R^1, for containing compressed air stored up and ready for use, and also with a brake cylinder, C^1, for applying the power by the usual piston and stem. When used as a part of the automatic apparatus the cock B^1 is kept in the position shown.

The engineer by his pump keeps up the desired air-pressure, and allows this pressure to be transmitted back, so that entering the coupling B^2 it shall pass, by the ports and passages b^1 b^2 b^3 c c^1 a^3, into the piston-chamber a, and by its pressure on the under side of the piston G shall seat it upward, as shown, and at the same time bring the valve H into the position shown. The compressed air, while still holding the valve G up, will pass, by the ports and passages s a^4 s^1 s^2 a^2 R, into the auxiliary reservoir R^1, so as to charge it and keep it charged at a working pressure. The valve H at the same time covers the ports e e^1, so that none of the compressed air thus introduced can escape through either; but such ports e e^1 being then and thereby brought into communication, any air in the brake-cylinder C′ above atmospheric pressure will escape, by C e^2 b e e^1, to the external atmosphere. The brakes will then be off, and the train in running condition.

Now, to apply the brakes with full force, the engineer, by opening a cock or valve in the brake-pipe, reduces the air-pressure therein, say, fifteen pounds per square inch, more or less. The pressure is then reduced in chamber a to a corresponding amount. Back pressure from auxiliary reservoir R^1 then depresses the piston G, so as to pass and cut off the supply-port s, and shifts the valve H, so that it shall uncover the port e, but cover e^1. Then the stored-up air in R^1 will pass the end of the valve H, and, by the ports and passages e b e^2 C, will go to the brake-cylinder C′, and by shifting the piston therein apply the brakes in the usual way. By restoring the pressure in the brake-pipe the engineer shifts the piston G up again to its upper seat, so as to reopen the line of supply-ports, and shifts the valve H to the position shown, so as to cut off communication from the auxiliary reservoir to the brake-cylinder, but open communication from the latter to the external atmosphere, as already described. The brakes are thus released. When the engineer wishes to apply the brakes with less than the maximum power he reduces the air-pressure in the brake-pipe a correspondingly less amount.

The position of the piston G in its chamber a is regulated chiefly by variations of air-pressure on its opposite sides, and by lessening or increasing slightly the air-pressure in a below the piston the position of the piston may be changed at pleasure, and with it, of course, the valve H.

It will be observed that the valve H has at h^2 a length and breadth of face such that it may entirely cover the port e. Hence the piston G may be brought down so that while entirely closing the supply-port s it shall bring the valve H to a position where it shall uncover only a small part of the port e, or any desired part. Then as soon as the desired amount of air-pressure has passed through e to the brake-cylinder a slight upward movement imparted to the piston G will cause the valve-face h^2 to cover entirely the port e, and remain in that position, so that the air already thus admitted to the brake-cylinder will be retained there, and the brakes will be held to the wheels with a corresponding force. By again lowering the piston G and with it the valve H this force may be increased by an

additional charge of compressed air; or by a farther upstroke the ports e and e^1 may be brought into communication, and the brakes so be released.

In order to render this operation of graduating the air-pressure in the brake-cylinders more easy and certain I employ the stem d^4 and spring d^2, with a degree of power in the spring approximately equal to the weight and friction of the piston and valve, and so arranged that when the desired amount of air-pressure has passed into the brake cylinder through the port e, and the air-pressure on the piston G is about the same above and below, the spring and stem will almost instantly shift the valve H so as to cover the port e and retain the pressure in the brake-cylinder. For practical purposes I deem it best that the stem d^4 should be of such length that the piston will engage it when the slide-valve H covers the port e, so as to cut off the supply of compressed air to and exhaust from the brake-cylinder. This pressure may then be increased or decreased at pleasure in the manner already described.

As water is sometimes condensed in the operations described, I provide for getting rid of it by a drain-port, q, and a drip-cup, q', screwed onto the lower end of the bush d^1.

1233 & 1234 As it sometimes happens that a car fitted up with the automatic apparatus is on a connecting line, made up into a train, the other cars of which are furnished with apparatus substantially such in some or all material features as that described in patent granted me April 13, 1869, it is important to convert the former into the latter. For this purpose I use the cock B^1. By turning it, as in Fig. 3, so that the port or groove b shall communicate at its opposite ends with the ports e^2 and b^1, it will be seen that all the rest of the apparatus will be effectually cut off, and a direct passage-way be made from the brake-pipe to the brake-cylinder. The compressed air is then turned on and turned off in applying and releasing the brakes in the manner generally practiced in that system of apparatus. Also, as it sometimes happens that the brake apparatus of a car will get out of order, so as to *to* be inoperative, I provide for cutting off such car in such emergency by bringing a full side of the cock B$'$ opposite the port b^1, which will prevent all ingress of compressed air; and in detaching a car from a train where the automatic brake is in use I provide against the application of the brakes by leakage or escape of the air from the chamber a by means of the same cock B$'$. For this purpose I shift it to the position shown in Fig. 3, or to any other position which will prevent the air in the reservoir R$'$ from being charged into the brake-cylinder C$'$; and for the purposes described any suitable form of four-way cock may be substituted, in combination with the same, or a substantially-like arrangement of ports.

The forms of the valves, ports, and communicating-passages, and to a certain extent their arrangement, may be changed, and all such modifications of the apparatus described as include a piston and slide-valve, operated by air-pressure, for charging alternately and successively an auxiliary air-reservoir and brake-cylinder, and do not materially depart in their combinations and modes of operation

from what is above set forth and hereinafter claimed, I hereby include as within the scope of my invention. Also, the reversible cock B′, with an arrangement of ports substantially such as described, may be used in connection with the automatic triple valve now in common use, or other like apparatus, the combination and function remaining in this respect substantially the same.

One reason for using and preferring a slide-valve, H, which may be of any known suitable construction, instead of a piston-valve, is that the former does not require any packing, and may be worked with less friction. I have found that any considerable amount of friction interferes seriously with that ready, accurate, and certain motion of the valve which is required in this kind of a device for the purpose set forth.

I claim as my invention—

1. In an air-brake apparatus, a moving piston arranged in the line of air communication, operated by air-pressure, and a slide-valve, H, connected therewith, in combination with suitable air ports and passages leading to an auxiliary reservoir and brake-cylinder, whereby such reservoir and cylinder will be charged with compressed air alternately and successively by the throw or motion of the piston and valve, substantially as set forth.

2. The port *s*, in combination with air chamber *a*, piston G, slide-valve H, and auxiliary reservoir and brake-cylinder ports, arranged substantially as set forth.

3. The slide-valve H, in combination with an air-reservoir and brake-cylinder, arranged and operative substantially as set forth.

4. In combination with the piston G, a suitable line of ports and passages, $s\ a^4\ s^1\ s^2\ a^2$, for supplying compressed air to the auxiliary reservoir while the piston is on its upper seat, substantially as set forth.

5. In combination with a piston, G, operated by air-pressure, a stem d^4, and spring d^2, substantially as set forth.

6. The port *q* in an apparatus substantially such as described, for draining off the water of condensation from the air chambers or spaces to a drip-cup, q'.

7. A reversible four-way cock, in combination with a single line of charging-pipe and supply-port therefrom, a brake-cylinder port, and ports leading to and from suitable automatic devices, substantially as set forth, whereby either of the modes described of operating the brakes may be employed at pleasure without changing the port of supply.

8. An arrangement of ports $b\ b^1$ in the cock B′, ports b^3 and *e*, communicating with the automatic apparatus, and ports $b^1\ e^2$, communicating with the brake pipe and cylinder, substantially as set forth.

In testimony whereof I have hereunto set my hand

GEORGE WESTINGHOUSE, JR.

Witnesses:

JOHN D. MORELAND.
S. HOWARD SPRAGUE.

G. WESTINGHOUSE, Jr.

AIR-BRAKE VALVE.

No. 172,064. Patented Jan. 11, 1876.

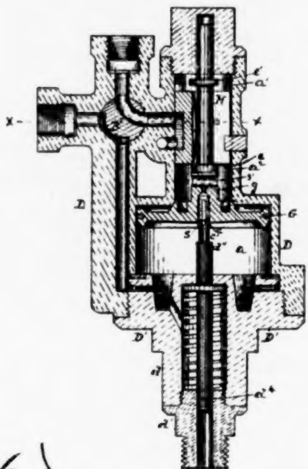


FIG. 1.

No. 403 r426
Westinghouse Co. v. Boyden Co. } p. 1236

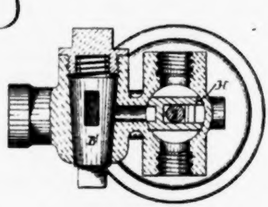


FIG. 2.

Witnesses.

Claudius L. Parker

J. E. Boggs.

Inventor.

George Westinghouse Jr.
by George H. Christy
his Atty.

37 UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., of Pittsburg, Pennsylvania.

Improvement in Air-brake Valves.

pecification forming part of Letters Patent No. 172,064, dated January 11, 1876; application filed December 18, 1875.

o all whom it may concern:

Be it known that I, George Westinghouse, Jr., of Pittsburg, county Allegheny, State of Pennsylvania, have invented or discovered a ew and useful improvement in air-brake valves; and I do hereby eclare the following to be a full, clear, concise, and exact descripon thereof, reference being had to the accompanying drawing, aking a part of this specification, in which—like letters indicating ke parts—

(Here follows diagram marked p. 1236.)

Figure 1 is a longitudinal sectional view of my improved valve; nd Fig. 2 is a transverse sectional view through the line *x x*, Fig. 1.

My present invention relates to an improvement in the valve deice patented to me October 5, 1875, by patent No. 168,359. It is tended for the same purpose as therein set forth, performs the me function, and includes only such changes in construction and peration as hereinafter set forth.

The valve-case D is the same, inclosing a like piston chamber, a, alve-chamber, a^1, and communicating passage a^2; also the screwp D′, with its air grooves and ports, and tubular extension d, and em-guide d^1; also the stem d^4, with its collar and spring; also the iston G, with its stem g, valve H, cock B′, and the passages and orts which lead from and to such valve and cock, and from and to n auxiliary reservoir, brake-cylinder, and brake-pipe.

All these devices, having by the prior patent become a part of the rior state of the art, need not here be more fully described.

My present improvement dispenses with the side port s in the alve-case, and provides for an air-port (herein also lettered s) diectly through the piston G, with one or more lateral ports s', open; ence into the passage a^2. The end of the port s next the chamber is made large enough for the insertion of a stem, c, of a somewhat ss diameter, such stem c being connected by an enlargement, c', to e end of the stem d^4. The smallest part c of this compound stem of the diameter of the smaller part of the port s, (or preferably a ttle less,) so that as the piston G makes a downstroke, c will enter he smaller part of s, and clean out any dust, dirt, or other obstrucion which may have lodged therein.

The enlargement c' of the compound stem is of such length, size, nd position relative to the piston G and the adjacent end of the ort s that when the devices are in the position shown, (the brakes

then being "off" and the train in running condition,) such e *s* will be open for the free passage of air from the brake-pipe t auxiliary reservoir; but with a diminution of air-pressure ir chamber *a* the back pressure of air from the auxiliary rese will shift the piston G, so that the port *s*, slipping onto the enla part *c*′, will be closed thereby, and the escape of air cut off i vance of the opening of the communication from the auxi reservoir to the brake-cylinder; and that this may be done wit having to overcome any resistance from the slide-valve H, I r the distance between the collars *c* c^1 a little greater then the le of the valve, as shown. Hence the port *s* will be closed befor valve H begins to move for applying the brakes, and will be closed until the valve H shall have been brought back to the p position for a full release of the brakes. Consequently the val can be operated as may be desired in applying and releasing brakes, and in graduating the brake-pressure, without leakag loss at the air-supply port *s*, and with such port always closed.

As the piston G continues its stroke it engages the end o part d^4 of the compound stem, with the operation and result s in the patent above cited.

It is not necessary that the port *s* should be of a reduced si any point; but I prefer to make it as small as practicable for plying the amount of compressed air desired, in order that t may be as small an escape as possible when the back pressu the piston G is brought into effective operation.

I claim herein as my invention—

1. The sliding piston G, having an air-port *s*, closed and op by sliding onto and off of a stem, *c*′, and in combination there substantially as set forth.

1238 2. The sliding piston G, having an air-port, *s*, in comb tion with the compound stem *c* and *c*′ d^4, substantially a forth.

3. The slide-valve H, made shorter than the distance betwee end bearings, in combination with the port *s* and stem *c*′, relati arranged with reference to the operation of the valve H, while port *s* is closed, substantially as set forth.

In testimony whereof I have hereunto set my hand.

GEORGE WESTINGHOUSE, J

Witnesses:

JAMES M. CHRISTY.
GEORGE H. CHRISTY.

l of
the
the
voir
ged
ad-
ary
out
ake
gth
the
ept
per
II
the
or

the
ted

at
up-
ere
on

ned
th,

na-
set

its
ely
the

Nos. 403 & 426.
Westinghouse Co v. Boyden Co } p. 1240

G. WESTINGHOUSE, Jr.
Automatic-Brake Relief-Valve.

No. 217.838. Patented July 22, 1879.

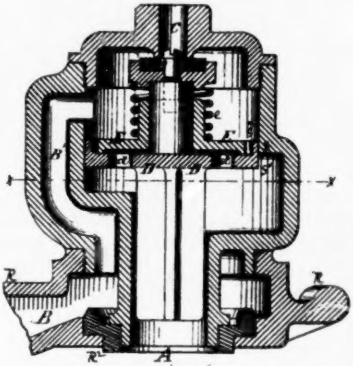


Fig: 1.

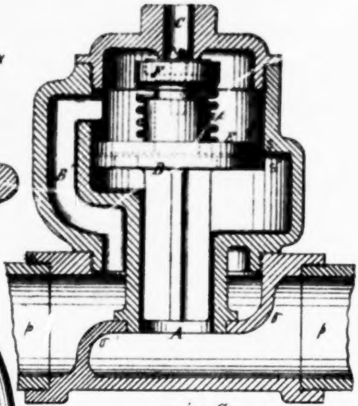


Fig: 3.

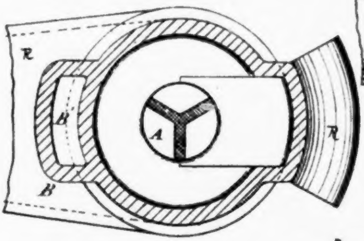


Fig: 2.

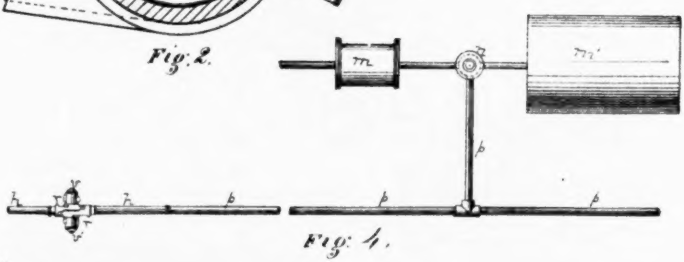


Fig: 4.

Witnesses
Francis L. Clark
Claudius L. Parker

Inventor George Westinghouse Jr.
By Attorney George H. Christy

1241 UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., of Pittsburg, Pennsylvania.

Improvement in Automatic-brake Relief-valves.

Specification forming part of Letters Patent No. 217,838, dated July 22, 1879; application filed May 21, 1879.

To all whom it may concern:

Be it known that I, George Westinghouse, Jr., of Pittsburg, county of Allegheny, State of Pennsylvania, have invented or discovered a new and useful improvement in automatic-brake relief-valves; and I do hereby declare the following to be a full, clear, concise, and exact description thereof, reference being had to the accompanying drawings, making a part of this specification, in which—like letters indicating like parts—

(Here follows diagram marked p. 1240.)

Figure 1 is a vertical sectional view of a relief-valve applied to and combined with a coupling of the class described in reissued patent No. 8291, granted to me June 18, 1878. Fig. 2 is a horizontal section thereof through the line *x x* of Fig. 1. Fig. 3 is a vertical sectional view, showing the relief-valve applied directly to a ported diaphragm in the pipe; and Fig. 4 shows in outline the main elements of an automatic brake of the kind or class to which the present invention is particularly applicable.

The present device is more especially designed for use with and as a part of brake apparatus of the class commonly represented by the Westinghouse automatic brake, in which the brake-power available for immediate use in the brake-cylinders is contained in auxiliary reservoirs, one under each car. The brake-pipes are also kept full of air under pressure, in order to keep the reservoirs fully charged, and the charge of compressed air in the auxiliary reservoirs is brought into action in the brake-cylinders by opening an escape-port leading from the brake or communicating pipes to the external air. A like effect follows when the train separates, or couplings become disconnected, or other accident ruptures or opens the air-conduit pipes. The brakes are then automatically applied.

Such an apparatus is partly shown in outline in Fig. 4, wherein *m* represents one of a series of brake-cylinders; *m'*, an auxiliary reservoir. *n* is the valve which governs the flow of compressed air from reservoir to cylinder, and from cylinder to escape. *p p* are the brake-pipes; *h*, the hose, and *r* the couplings. The main reservoir and operating-cock on the locomotive are of the usual construction. The relief-valves are represented at *v v'*.

It sometimes happens with such brake apparatus, especially in case of accident, that material advantage could be effected by having all the brakes of the train applied or brought into action simul-

BLEED. THROUGH POOR COPY

taneously, or as nearly so as possible. To accomplish this it is only necessary to make provision for the simultaneous opening of one or more ports in the air-conduit passages at points not remote from each auxiliary reservoir. For this purpose I arrange at such various parts of the air-conduit or communicating pipes as may be desired, but by preference at the couplings, relief-valves of the kind shown in the drawings. In the construction there shown the valve-box forms a part of the coupling itself.

The aperture A of the valve-box is seated in the lateral port-opening of the coupling R, so as to come in the line of the flow of air through the brake-pipe, hose, and couplings.

The aperture A communicates with the port of the next half-coupling, and the aperture B leads to hose and brake-pipe. A third aperture, C, opens to the external air.

Within the valve-box is a piston, D, with holes *d* through it, covered by a valve, E, held down by a spring, *e*. On the stem of the piston is fixed a valve, F, which covers the aperture C.

When compressed air enters the valve-box by the aperture A from the front portion of the communicating pipe, it raises by its pressure the valve E, passes through the holes *d* in the piston D, keeps the valve F closed, and passes on by the passage B′ and aperture B to the hinder part of the pipe to charge the auxiliary reservoirs, in the usual way. But should the pressure in the front part of the pipe communicating with A be reduced intentionally or by accident, then, the valve E closing the holes in the piston D, that piston is pressed down by the pressure from B, and the valve F is drawn from its seat, leaving the orifice C open for the escape of air from the hinder portion of the pipe which communicates with B; and by giving the piston D and valve E a sufficient length of stroke or motion, such that it will drop below the shoulder *s*, an open passage-way will be formed for the escape of fluid-pressure from the enlarged space or port s^1 to s^2, and thence out at C. In this
1242 way provision is made for the escape of fluid-pressure through C from the brake-pipes both forward and back of the couplings.

By arranging such valve-boxes at several points along the communicating pipe, each section of that pipe becomes relieved from pressure almost immediately on the section in front of it being relieved, and consequently the several sets of brakes throughout the train are put in action without the loss of time which would be involved if, for the relief of pressure throughout the pipe, the air contained in the hinder portions of it had to flow all the way to the escape-aperture, which might be near its front part, and is usually on the locomotive.

The same device may be applied at any part of the communicating pipes *p* by making therein, across the bore of the pipe, a ported diaphragm, *o*, Fig. 3, such as is used in ordinary stop-cocks, and arranging therein a relief-valve of the construction described, as shown in said Fig. 3; and so far as relates to the relief-valve, the ported diaphragm *o* and the ported part R^2 of the coupling are the mechanical equivalents each of the other. The form or construc-

tion of the relief-valve, its function and operation being substantially retained, may be varied considerably, in so far as it is an element in the described combination, without any material departure from the scope of the invention.

I am aware of the prior use of escape-valves, in combination with brake-cylinders, for the purpose of effecting a reduction of the working-pressure in such cylinders; but in the present invention the escape-valve enters into combination not only with the brake-cylinder, but also with the auxiliary reservoir, and in such a manner as to secure a result the reverse of that just stated—viz., to facilitate the charging of the compressed air from the auxiliary reservoir into the brake-cylinder.

I claim herein as my invention—

1. In combination with the brake-cylinders and auxiliary reservoirs of an automatic-brake apparatus, a ported diaphragm arranged in the line of fluid-pressure communication, and a valve device, which, under operative fluid-pressure, closes the external air or escape port, and opens a through passage-way for the air, and on the reduction of air-pressure in the main air-conduit, by accident or otherwise, will open the escape-port, substantially as set forth.

2. A relief-valve applied directly to and made as a part of a coupling, the combination of such two elements being substantially as described.

3. The valves E F, and ported piston D, in combination with ports or ways A B C, substantially as set forth.

In testimony whereof I have hereunto set my hand.

GEORGE WESTINGHOUSE, Jr.

Witnesses:

CHAS. BERKLEY HARRIS,
17 *Gracechurch Street, London, E. C.*

JNO. DEAN,
17 *Gracechurch Street, London, E. C.*

1247 UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., of Pittsburg, Pennsylvania.

Improvement in Regulating-valves for Automatic Brakes.

Specification forming part of Letters Patent No. 220,556, dated October 14, 1879; application filed September 17, 1879.

To all whom it may concern:

Be it known that I, George Westinghouse, Jr., of Pittsburg, county of Allegheny, State of Pennsylvania, have invented or discovered a new and useful improvement in regulating-valves for automatic brakes; and I do hereby declare the following to be a full, clear, concise, and exact description thereof, reference being had to the accompanying drawings, making a part of this specification, in which—like letters indicating like parts—

(Here follow diagrams marked pp. 1244 & 1246.)

Figure 1, sheet 1, is a vertical sectional view of the triple-valve device illustrative of my improvements. Fig. 2 is a transverse horizontal section in the line *x x* of Fig. 1. Fig. 3 is a detached sectional view of the slide and auxiliary valves, valve seats, and stems, as shown in Fig. 1, but with the auxiliary valve in a different position; and Fig. 4, sheet 2, by a view similar to Fig. 1, illustrates some modified features of construction.

In the class of fluid-pressure brakes for railway-trains commonly known in this country as "automatic brakes," a device usually termed a "triple valve" is extensively used. This device, in two of the many forms in which it has been patented, is shown and described in United States patents granted to me October 5, 1875, No. 168,359, and January 11, 1876, No. 172,064, as well as in various other earlier and later patents.

It is important in such device that the valve (lettered H in said two patents and herein) which governs the flow of air or other fluid shall move not only with great certainty to any desired position, but also shall move with slight variations of pressure on the piston, (lettered G,) so that the application of the brakes with any desired power, and their ready release, may be quickly and easily effected at the pleasure of the engineer.

To this end I combine with the said valve H, giving it a slight range of motion on its stem, an auxiliary valve operated by the same stem, in such manner that a portion of the functions performed in said patents by the valve H may now be performed by such auxiliary valve, the latter moving with practically no resistance, and hence moving more quickly and with less pressure than the valve H itself. The same auxiliary valve is also designed for use, under certain circumstances, as a leakage-valve. In the drawings I have shown it as applied to or embodied in a triple valve

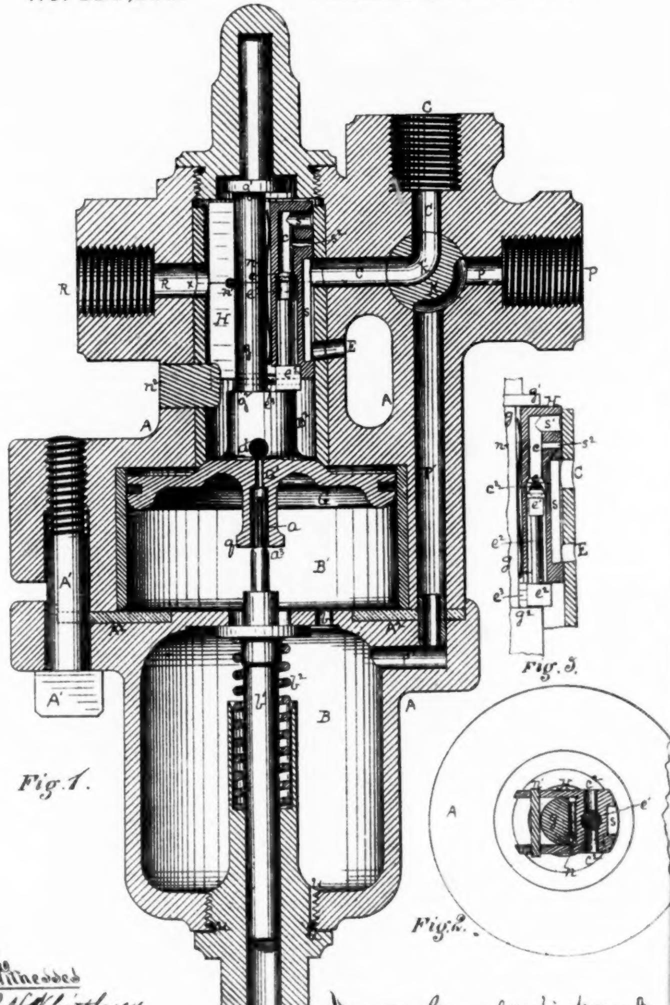
Nos 4, 5, 3, 4, 26.
Westinghouse C.
Boyden C.
p. 1244

2 Sheets—Sheet 1.

G. WESTINGHOUSE, Jr.

Regulating-Valve for Automatic-Brakes.

No. 220,556. Patented Oct. 14, 1879.



Witnesses
R. H. Whittlesey
C. L. Parker

Inventor George Westinghouse Jr.
By Attorney George H. Christy

BLEED THROUGH POOR COPY

7996

No. 403 r 426.
Westinghouse Co. } p. 1246
Boydau Co.

2 Sheets—Sheet 2.

G. WESTINGHOUSE, Jr.

Regulating-Valve for Automatic-Brakes.

No. 220,556. Patented Oct. 14, 1879.

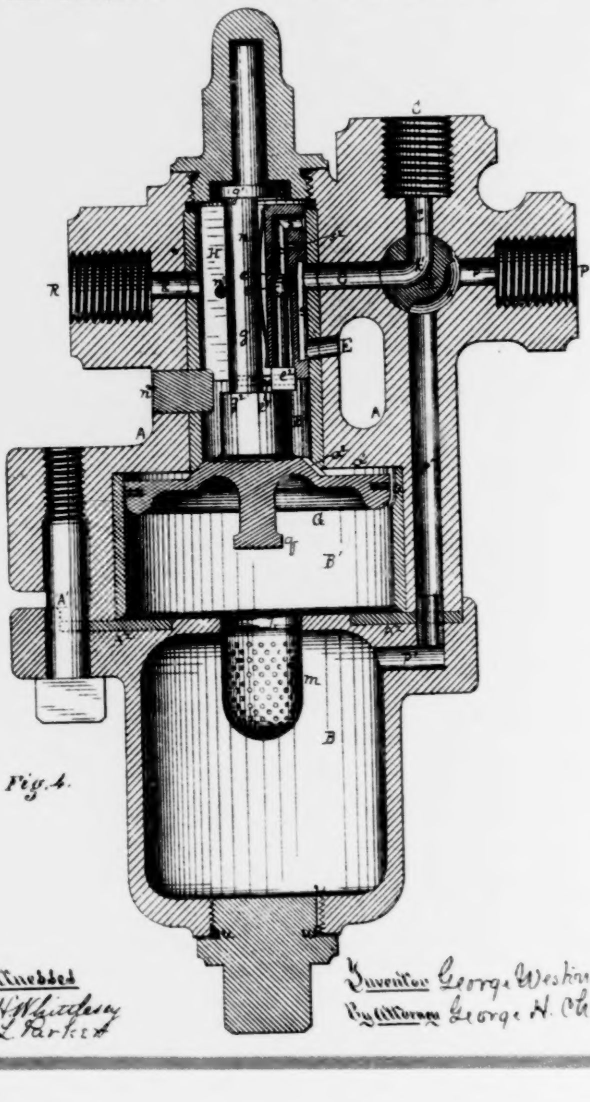


Fig. 4.

Witnesses
R. H. Whittlesey
C. L. Parker

Inventor George Westinghouse Jr.
By Attorney George H. Christy

BLEED. THROUGH POOR COPY

having the graduating-stem and spring of said patents, and also as used without them. The former will be first described with reference to Figs. 1 to 3.

A represents the valve-case, made preferably in two parts, united by the necessary number of screw-bolts A^1, with interposed packing A^2.

B is a drip-chamber; B^1, the cylinder in which the piston G is operated, and B^2 is an upper chamber, through which the fluid passes under pressure to the auxiliary reservoir by the port R, or to the brake-cylinder by the port C. It is also a valve-chamber for the slide-valve H, which is secured on the stem, in any suitable way, by a pin, n^1, going through the back U-shaped wings of the valve, and is held to its seat by any suitable spring, as at n, and rotation on the stem is prevented by a stud, n^2.

A cock, K, with ports $k\ k'$, is arranged in the line of fluid-pressure communication, substantially as represented, and for purposes which will be understood by reference to said patents.

From the port P connection is made with the brake-pipe, and from the port C with the cylinders. With the devices in the position shown in Fig. 1 the brake apparatus is in the normal condition for the running of the train. The fluid-pressure then enters the port P, passes by k P′ into chamber B, through port b into B^1 beneath the piston G, and holds the latter up in the position shown. It then passes through ports $a\ a^1\ a^2$ into chamber B^2, and thence to the auxiliary reservoir through port R.

The details of construction and the functions of these parts will be readily understood from the drawings and the patents above named.

The graduating-stem b^1 and spring b^2, including the reduced upper end of the stem, have also the construction and operation described in the second of said patents.

The piston-stem g operates the valve H; but the collar g^1 and shoulder g^2, which bear on the opposite ends of the valve or
1248 its connections and give it its motion, are a little farther apart—say about one-eighth ($\frac{1}{8}$) of an inch, more or less—than the distance between the end bearings of the valve H.

The distance between the open end of the port a and the shoulder a^3 on the stem b^1, when the piston G is at the highest point of its stroke, is by preference somewhat less—say one-sixteenth ($\frac{1}{16}$) of an inch, more or less.

The valve H has a cavity, s, long enough to uncover the port C and the exhaust-port E and put them in communication. It has also two additional ports, $s^1\ s^2$, the former having a diameter, by preference, of about three-sixteenths ($\frac{3}{16}$) of an inch, and the latter of about five-sixty-fourths ($\frac{5}{64}$) of an inch, in a device of the proportions shown; but I do not confine myself in my invention to these exact figures or proportions, but include all such variations therefrom as give substantially a like construction and operation.

The distance between the ports s and s^1 is equal to or slightly in excess of the diameter of the port C at the valve-seat. The port s^1 communicates by a passage, c, with the open end of the valve H.

Transverse to this passage, and opening therein, is a cross-port, c^2, Fig. 3, extending to the exterior of the valve H on one or both sides. Between the point of junction of this port with the passage c and the port s^1, I make a valve-seat, e, and seat thereon a valve, e^1, the stem e^2 of which is connected by a pin, e^3, with the stem g.

It will now be seen that any motion imparted to the piston G, Fig. 1, will, through the stem g, be first operative in unseating the valve e^1, the valve H being held by frictional contact with its seat, so that the stem g will slide through it until the collar g' engages the upper end thereof. Also, after any portion of an up or down stroke is made by the piston G, the first motion thereof in an opposite direction will first shift the auxiliary valve e^1 to or from its seat, as the case may be, before any motion is imparted to the valve H.

In order now to apply the brakes fluid-pressure is allowed to escape from below the piston G by the manipulation of the cock on the locomotive or other escape-cock. Fluid-pressure then acts back from the auxiliary reservoir on top of G, and forces it down, first closing the port a, and at the same time unseating the valve e^1, and bringing the latter and the devices immediately connected therewith into the relative positions shown in Fig. 3. But a very slight reduction of pressure below G is required in order to do this. The downstroke of G is continued, shifting the valve H downward rapidly or slowly, until the port s^1 comes partly or fully into line with C.

The escape at E is then closed, and the ports and passages are open for fluid-pressure to pass from the auxiliary reservoir by R, c^2, c, s^1, and C to the brake-cylinder and cause the application of the brakes. In this motion of H, however, it should be noted that the small port s^2 is, while passing the open end of C, in communication with the exhaust E; but the amount of air thus escaping through a port so small is practically inappreciable, and does not interfere with the action described. When now the valve H is thus shifted, so that the port s, shall, to the extent of one-quarter or one-half its capacity, more or less, as is usual when less than a maximum braking force is desired, be thus brought into communication with the port C, and held there until the limited or desired amount of fluid-pressure shall have passed into the brake-cylinder, the auxiliary valve e^1 becomes available as a quick and ready means of closing the supply-port with certainty, without danger of opening the exhaust. To this end a very slight increase or excess of pressure below the piston G—much less, in fact, than is necessary to shift the valve H—will suffice to move the piston G and stem g far enough to close the valve e^1 on its seat e. All ports are thus closed by an almost instantaneous motion, and the brakes remain on with a force corresponding to the amount of pressure previously charged into the brake-cylinder.

In case a slight addition to the operative braking force is desired, either to compensate for loss by leakage or for any other reason, it may be secured by a slight downward motion of the piston G, such as will unseat the auxiliary valve e^1. In this manner the graduating friction may be more advantageously performed than heretofore.

But the use of this auxiliary valve enables me to dispense entirely with the graduating stem and spring, and in this combination it is illustrated in Fig. 4, sheet 2.

With the valve H of the patents above named, if the graduating spring and stem were omitted it would be found that after the slide-valve H had been so far shifted in applying the brakes as to permit a moderate or limited quantity of fluid-pressure to pass from the auxiliary reservoir to the brake-cylinder, in such case the amount of power of fluid-pressure necessary to shift such valve part way back, and thus close the port leading to the brake-cylinder, and thereby hold or retain the limited amount or degree of pressure in the brake-cylinder, would frequently give such valve its entire throw and result in the release of the brakes. The important function of graduating would thus be to some extent interfered with, since it is desirable in the handling of a train to be able to admit into the brake-cylinders any desired amount or degree of fluid-pressure less than the maximum, and to retain or hold it there without material increase or diminution. This tendency of the valve referred to, to complete its back stroke under the circumstances named, results, in part, from the fact that the amount of force necessary to start the valve upward when the graduating-spring is not employed is frequently found to be more than enough to carry it to the end of its stroke after it is started. But with the explanation already given, it will be seen that the necessity of giving a back stroke
1249 & 1250 to the valve H is wholly obviated, so far as relates to closing the ports and holding in the brake-cylinder any predetermined or limited amount of fluid-pressure, or to increase such pressure at pleasure, since, after the slide-valve H has been brought to the desired position, as set forth, a slight motion imparted to the piston G, and much less than would be necessary to start the valve H, will suffice to seat and unseat the auxiliary valve e^1, and so hold or retain in the brake-cylinder any desired pressure previously charged therein, or permit the increase thereof at pleasure.

Another part of my invention relates to the use of the auxiliary valve e^1 as a leakage-valve. When a car is disconnected from the train and run onto a siding, the auxiliary reservoir and brake-pipes are still charged with fluid-pressure. Leakage from the pipes, where it is greatest, results in the depression of the piston G until the port s^2 comes wholly or in part opposite the port C. As the intermediate full face of the valve is insufficient to cover entirely the port C, (the auxiliary valve e^1 being now unseated,) the fluid-pressure from the auxiliary reservoir will pass out slowly through s^2, s, and E, but about as fast as it will leak from the brake-pipes. Were it not for this port s^2, or some other leakage device, the port s^1 would be brought into communication with the port C so as to apply the brakes slowly at first, but eventually with maximum force, and hold them on for a considerable time. This would be highly objectionable, as it would interfere with the shifting of cars and other like operations, or even the running of a car, in case the brake apparatus of such car were disconnected, which it is sometimes necessary to do.

By the same device I provide for unexpected or accidental fluc-

tuations of pressure slight in amount, such as are liable to occu while the pipes are connected and the train running, without da ger of the brakes being applied thereto.

In Fig. 4 I have shown a strainer, *m*, arranged over the po leading from B to B¹, as a device to exclude or aid in excludi dust; also, in this figure, the ports from B¹ to B² are shown past t piston G instead of through it.

In both forms of the device I have shown a knob, *q*, projectin from the lower side of the piston G, as a device by which to get ho of the piston and pull it out, when necessary, for purposes of r newal, cleaning, or repairs. The necessity for this results from t fact that heretofore careless workmen have often used the gradua ing stem for this purpose, and in doing so have bent the stem a caused trouble in the working of the valve.

The function of the large chamber B is chiefly that of a drip-cu and to discharge the drip a hole and groove are made at *u*.

While in order to make my improvements clearly understood have described and specified the devices with some minuteness, still include herein known mechanical equivalents, or such subst tutes for devices specified as involve a substantially like operatio and result.

I claim herein as my invention—

1. In combination with the piston and stem of a triple valve, valve, H, arranged on such stem, and having a short range of m tion independent of such stem, in combination with an auxilia valve operated by the same stem to close or open a port throug the main valve without necessarily moving the main valve, substa tially as set forth.

2. In a valve-case having a fluid-pressure-supply port, an auxi iary reservoir-port, a brake-cylinder port, and exhaust-port, a valv H, for governing the flow of air, provided with ports or passages *s s* and a fluid-pressure-supply port communicating with s^2, in com bination with piston G, substantially as set forth with reference t the exhaustion without application of the brakes of the containe fluid-pressure.

3. The valve H, having cavity *s*, ports s^1, s^2, *c*, and c^2, in combin tion with valve e^1, substantially as set forth.

4. In combination with a triple valve of the class described, strainer, *m*, arranged inside the valve-case and over or across th port leading to the piston-chamber, substantially as set forth.

In testimony whereof I have hereunto set my hand.

GEO. WESTINGHOUSE, JR.

Witnesses:

R. H. WHITTLESEY.
GEORGE H. CHRISTY.

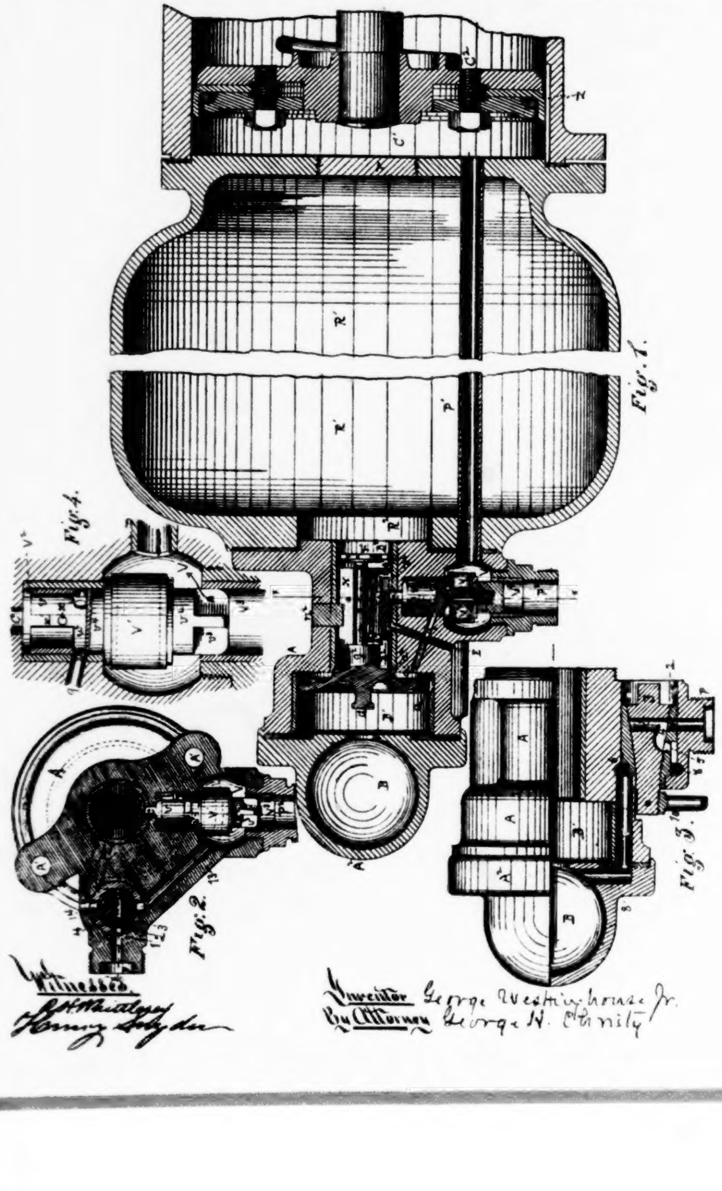
Nos. 4403 & 4426.
Westinghouse Co. } p. 1252
Boyden Co.

(No Model.)

G. WESTINGHOUSE, Jr.

Fluid Pressure Brake.

No. 235,922. Patented Dec. 28, 1880.



Witnesses
R. H. Whittlesey
Harry Snyder

Inventor George Westinghouse Jr.
By Attorney George H. Christy

1253 UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., of Pittsburg, Pennsylvania.

Fluid-pressure Brake.

Specification forming part of Letters Patent No. 235,922, dated December 28, 1880. Application filed November 15, 1880. (No model.)

To all whom it may concern:

Be it known that I, George Westinghouse, Jr., of Pittsburg, county of Allegheny, State of Pennsylvania, have invented or discovered a new and useful improvement in fluid-pressure-brake apparatus; and I do hereby declare the following to be a full, clear, concise, and exact description thereof, reference being had to the accompanying drawings, making a part of this specification, in which—like letters indicating like parts—

(Here follows diagram marked p. 1252.)

Figure 1 is a sectional view of so much of a brake-cylinder, auxiliary reservoir, and air-regulating valve and connections as is necessary in order to illustrate my present invention. Fig. 2 is a cross-section in the plane of the line *x x*, Fig. 1. Fig. 3 is a section of one-half of Fig. 2 in the plane of the zigzag line *x'* to the center, and an outside elevation of the other half, and Fig. 4 is an enlarged view of the double check-valve of Fig. 1. As the moving parts of the triple-valve device (above termed "air-regulating valve") are well known in the art, I have shown them only in Fig. 1.

My present invention relates to certain improvements in the construction and combination of appliances to be used in and as a part of fluid-pressure-brake apparatus for railway use, and while it is especially adapted for use in what is commonly known as "automatic-brake" apparatus, I also so construct it that it may be used in the non-automatic system of construction and operation—that is, where the fluid-pressure is conducted directly from the source or magazine of power to the brake-cylinder whenever the brakes are to be applied, and on the opening of a cock or valve by the engineer for that purpose. In the automatic system, on the other hand, the fluid-pressure is commonly conducted from the main reservoir or source of power, and stored in auxiliary reservoirs on the several cars, and a valve device, shifted by variations in the air pressure, is arranged in connection with the apparatus in such manner as that, on the accidental or intentional reduction of fluid-pressure in any of the conduit-pipes, a port will be opened from each auxiliary reservoir to a brake-cylinder.

In my present invention I unite in what may be termed a "single structure" the brake-cylinder, the auxiliary reservoir, and the valve apparatus employed for giving proper direction to the flow of the fluid-pressure, and thereby I greatly simplify the construction, make it more compact and at a less cost, and, by dispensing with numerous joints, lessen the liability of loss by leakage, as well as render it

more durable; and by adding in the same combination another of pipe with suitable connections, valve, and ports, I make provi for switching out or cutting off the automatic features, so that a so fitted may be used with other cars having only the u appliances for non-automatic operation, and all in a more sin manner than any described in my previous patents.

In the drawings, R′ represents the auxiliary reservoir, and C′ brake-cylinder, made so as to be secured together end to end. hole in the dividing wall or diaphragm, made for convenience casting, is closed by a plug, r. Holes are also made in the walls of the reservoir R′, and a pipe, P″, extends from one to other, through which to convey the fluid-pressure to the br cylinder. The outer end of the pipe leads to a valve-chamber and its use will presently be described. The outer end of the ervoir R′ has also a large open port, R^2, and over this port is secu by bolts through bolt-holes A′, the valve-case A of what is commo termed in the Westinghouse-brake system a "triple valve." T device, in consequence of various improvements, has practica ceased to be a triple valve; but as it is commonly known by t term the name may, for convenience, be retained. This device substantially the construction and operation described in Uni States patent granted to me October 14, 1879, No. 220,556, illustrated in Fig. 4 thereof, except that, instead of having a s port and pipe-connection leading to the auxiliary reservoir, open end of the valve-case is directly opposite to and opens into port R^2, so that this communication is always open; also, the val stem g, having no end socket in which to be guided, as in the pat above named, is guided by a winged disk, r′, the wings of wh play on the walls of the valve-chamber B^2. The ot er parts this triple-valve device, so far as they are like hose in
1254 patent above named, are similarly lettered, and ; refere thereto their construction and operation will be read understood; but instead of the leakage port in that patent (lette s^2) in the slide-valve H, I carry a groove (here indicated by same letter) to the port s′; but the operation is not substantia changed thereby. Other devices described in said patent 220,556, and not here shown, may be omitted or used, as preferr so far as the same are suitable for use in this construction

The cap A^2 of the triple-valve case contains a chamber, B, wh opens into the piston-chamber B′. The line of pipe through wh fluid-pressure is transmitted for the automatic operation of apparatus is connected at P. From this point a line of ports le first, at 1, Fig. 3, into a cock-case, 2, wherein is a plug, 3, havin notch or recess, 4, through which the fluid-pressure passes to a p 5; thence into an annular chamber, 6; thence, by vertical a horizontal ports 7 and 8, into the chamber B. Through this li of ports fluid-pressure is introduced and let off, so as to operate triple valve, as described in said patent No. 220,556; but for non-automatic operation of the brakes I connect the fluid-pressu conduit-pipe at P^2. It will now be seen that this pipe-connecti opens into the valve-chamber V on one side, and that the tri

valve opens into the same chamber on the other side. In order to cut off at pleasure one line or the other of air conduit or communication, I arrange in this chamber a double check-valve, V′, which seats both ways. This double check-valve has a tubular extension, v, which slides like a piston inside the chamber V^2. From this chamber a side port, 9, leads to the escape-port E, or may lead directly to the atmosphere, and when these devices are in the position shown in Fig. 1, (which is the position for the non-automatic action,) a slit or port, u^2, in the tubular extension v registers with this side port through port u in the bush or lining of the chamber. Other ports, u', are also made in this tubular extension, for purposes presently to be explained. A pin, x, on which the tubular extension plays, by a slit, x' prevents the rotation of the extension. The opposite or outer end of the double-check-valve stem has a cylindrical part, v^2, which, when the valve is shifted outwardly, fills the adjacent end of the bore of the chamber V^3 as soon as the opposite or automatic port is opened, and outside of this is a winged stem, v^3.

Assuming now that the non-automatic system of operation is to be used, fluid-pressure, entering at the port P^2, shifts the double check-valve V′ over to the position shown, so as to cut off the automatic feature from the line of communication. The fluid-pressure then passes, as indicated by the arrows, Fig. 4, into and along the pipe P′, to the brake-cylinder C′, and there does its work in the usual way. If, then, at the same time, either accidently, by design, or in consequence of leakage, any comparatively small amount of fluid-pressure should come through the triple-valve ports into the tubular extension v, it will at once pass out by the ports 9 and E; but if it be desired to employ the automatic system of operation, the reservoir R′ is charged, (if not already charged,) and on the reduction of the pressure in the brake-pipe the triple valve is shifted, so as to let the pressure pass from R′ through the port R^2, shift the piston G and valve H, so as to uncover the port C, and thence through this latter port into the tubular extension v. As the port u is too small to provide for its escape, it acts to throw the double check-valve V′ outward and close the non-automatic port. This brings the holes u' and slit u^2, made in the walls of the tubular extension v, outside the valve-seat at that end of the chamber, or, in other words, causes them to open into the valve-chamber V; and it will be observed that this end of the valve-stem has a cylindrical port, v^4, so that the ports u' u^2 are not uncovered until the cylindrical part v^2 on the other end of the valve shall have practically closed the non-automatic port. The fluid-pressure thus introduced passes by the pipe P′ to the brake-cylinder, and also does its work in the usual way. The brakes may be released in the manner described in said patent No. 220,556.

The apparatus thus described I propose to use either as automatic or as non-automatic, with a single line of pipe; or, what is still better, I propose to use two lines of pipe, and use either method of operation at pleasure, or sometimes one and sometimes the other. For holding a long passenger or freight train in check on a long

downgrade, the non-automatic method of working is in some respects preferable, whereas for stopping purposes, particularly in an emergency, the automatic is much the better. Hence on roads in hilly or mountainous regions it is well to have both methods available, at the pleasure of the engineer, and in such use the automatic apparatus should always be kept charged and in a usable condition, so that it may be used or made available for an emergency stop, or in case of accident, as well as for ordinary stops, even while the non-automatic apparatus may be employed at intervals for certain purposes; but in case it should become necessary, as it sometimes does, to exhaust or discharge the compressed fluid-pressure from the brake-cylinder R', it may be done by the turning of the plug 3 (a handle, 10, being added for the purpose) so as to bring the port 12 into line with the ports 13 and 14, Fig. 2, the former of which is in communication with the valve-chamber V, and the latter of which opens to the outer air. This necessity may arise when a car is detached from the train, and by the escape of air from the brake-pipe the brakes are set and remain so.

It is also an important and novel characteristic or feature of my present apparatus that I provide for the discharge of the
1255 & 1256 fluid-pressure from all the auxiliary reservoirs of the train
by the use of a higher or a mechanically more effective pressure through the non-automatic pipe. Thus, in case of the bursting or breakage of any of the fluid-pressure conduits of the automatic apparatus, (which may occur while the train is at a place or point on the line where repairs are almost practically impossible,) the pipe-valves throughout the train are shifted, and fluid-pressure then passes from each auxiliary reservoir to its brake-cylinder, and all the brakes are set. Of course they can be released in the manner already described; but I deem it better in such cases to discharge the fluid-pressure from the auxiliary reservoirs, so that the brakes cannot in any contingency again be reset by a new charge from such reservoirs. To this end I pump up, if need be, and transmit back through the non-automatic pipe, a pressure sufficient to shift each valve V', as against the pressure to which it may be subject from its auxiliary reservoir, so as to cause the port or slit u^2 to register with the port u, and thereby allow all the pressure in all the auxiliary reservoirs to escape through ports 9 and E to the open air. This being done, the brakes may be released in the manner common in the working of the non-automatic brake, and the train may proceed, using then the latter apparatus for braking purposes until damages are repaired; but in the operation thus described the plug 3 is presumed to be absent, or, if present, to be closed as regards the ports 13 and 14.

The plug 3 may be used to cut off the automatic apparatus entirely, when desired, by setting it so as to cut off all the ports leading into or through the same.

In order to guard against the effects of the leakage of fluid-pressure into the brake-cylinder, (when it occurs,) I make a small groove, z, in the interior of the cylinder, past the piston C^2 when it is at the end of its back-stroke, or when the brakes are off; and I make this

groove large enough to provide for the escape of so much fluid under pressure as is liable to leak into the cylinder, but so small that it cannot carry off an operative charge or quantity. As soon as the piston on its forward or outward stroke laps onto the outer end of the groove, the latter ceases to perform any function whatever.

In lieu of the specific form or construction of triple valve described, any other known form of device for regulating and governing the flow of fluid-pressure in a substantially like manner by the action of the fluid-pressure itself may be substituted without any substantial departure from the scope of the present invention, and such substitutes, performing a like function, I include within the term "triple valve," as hereinafter used; and, particularly, it may be stated that for some uses the triple valve may be arranged on one side of the reservoir R′, instead of at its end, both arrangements thereof being included herein, and like variation may be made in the arrangement of the brake-cylinder.

I claim herein as my invention—

1. In a fluid-pressure-brake apparatus, a triple valve, auxiliary reservoir, and brake-cylinder arranged end to end in a single structure, without interposed pipes to connect one to the next, substantially as set forth.

2. The combination of a brake-cylinder furnished with a piston moving therein, arranged on one end or side of a reservoir, a triple valve arranged on another end or side, and a pipe connecting the triple valve with the brake-cylinder, substantially as set forth.

3. A valve-chamber, V, containing a double check-valve, in combination, by port C and pipe P″, with triple valve, auxiliary reservoir, and brake-cylinder, substantially as set forth.

4. A double check-valve, V′, having a ported tubular extension, v, thereon, in combination, by ports C, E, and 9, with triple valve, substantially as set forth.

5. The double check-valve V′, having cylindrical extensions v^4 v^2 and ported tubular extension v, as a device for cutting off one of two different sets of fluid-pressure-brake apparatus while bringing the other into communication, substantially as set forth.

6. The cock and case having line of ports and passages 1, 4, 5, 6, 7, and 8, substantially as set forth.

7. The cock 3, in combination, by ports 12, 13, and 14, with chamber V and passages thence to auxiliary reservoir and brake-cylinder, substantially as set forth.

8. In a fluid-pressure-brake apparatus having automatic and non-automatic appliances and a pipe-connection for each, the method of discharging the fluid-pressure from the auxiliary reservoirs of the train, by charging through the non-automatic connection a pressure sufficient to shift a valve and open an escape-port communicating with each such reservoir, substantially as set forth.

In testimony whereof I have hereunto set my hand.

GEORGE WESTINGHOUSE, Jr.

Witnesses:
R. H. WHITTLESEY.
GEORGE H. CHRISTY.

1261 UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., of Pittsburg, Pennsylvania.

Air-brake Apparatus.

Specification forming part of Letters Patent No. 243,415, dated June 28, 1881. Application filed April 1, 1881. (No model.)

To all whom it may concern:

Be it known that I, George Westinghouse, Jr., of Pittsburg, county of Allegheny, State of Pennsylvania, have invented or discovered a new and useful improvement in air-brake apparatus; and I do hereby declare the following to be a full, clear, concise, and exact description thereof, reference being had to the accompanying drawings, making a part of this specification, in which—like letters indicating like parts—

(Here follow diagrams marked pp. 1258 & 1260.)

Figure 1, sheet 1, is a longitudinal sectional view of the "triple" or automatic valve employed in my present improvement, with its ports and connections, and also showing, in part, an auxiliary reservoir and valve-chamber. Fig. 2 is a transverse sectional view in the plane of the line x x of Fig. 1, looking to the left, and showing the cock, plug, or key K in elevation. Fig. 3 is a side elevation of the triple-valve case as looked at from the left of Fig. 2; and Fig. 4, sheet 2, is a diagram view illustrative of the organization of a brake apparatus embodying the present improvements.

My present invention is more particularly directed to the construction and combination of apparatus whereby the two styles or systems of air-brake apparatus commonly known as the "Westinghouse compressed-air brake" and the "Westinghouse automatic brake" may be combined in use and operation at the same time on the same train.

While I do not limit myself to any particular train use of this combination, I have devised it with particular reference to train purposes, especially on roads which have long and heavy grades, and where a moderate but comparatively constant degree or amount of brake-power has to be applied for a considerable time; and I also provide an improved means for releasing and cutting off or out of action the automatic part of the apparatus in case, for any reason, it should get out of order when out on the line where repairs can not be made.

Some of the features of construction of the present apparatus are shown in patent No. 235,922, granted to me December 28, 1880. Here, as there, the brake-cylinder, the auxiliary reservoir, and the valve-case which contains the valve apparatus employed for giving proper direction to the flow of the fluid-pressure in the automatic brake, are, by preference, included in what may be termed a "single

No. 403 0426.
Westinghouse Co. } p. 1258.
Bryan Co.

(No Model.) 2 Sheets—Sheet 1.

G. WESTINGHOUSE, Jr.

Air Brake Apparatus.

No. 243,415. Patented June 28, 1881.

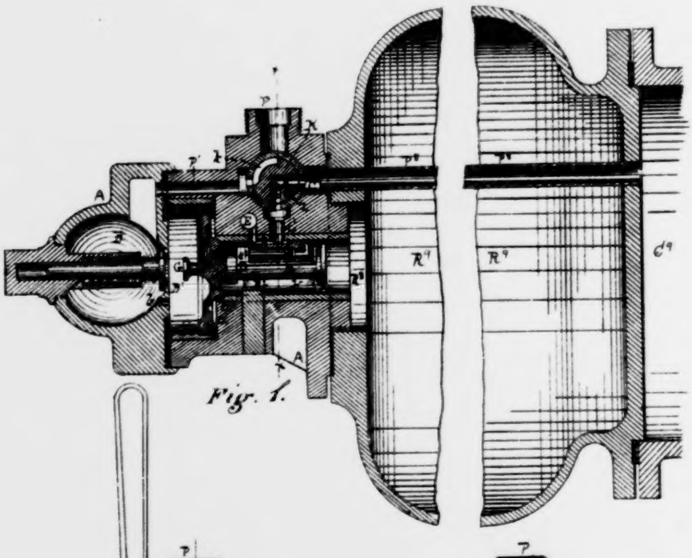


Fig. 1.

Fig. 2.

Fig. 3

Witnesses
R. H. Whittlesey
C. L. Parker

Inventor George Westinghouse Jr.
By Attorney George H. Christy

BLEED THROUGH POOR COPY

Nos. 403 & 426.
Westinghouse Co } p1260
Boyden Co

(No Model.)

2 Sheets—Sheet 2.

G. WESTINGHOUSE, Jr.

Air Brake Apparatus.

No. 243,415.

Patented June 28, 1881.

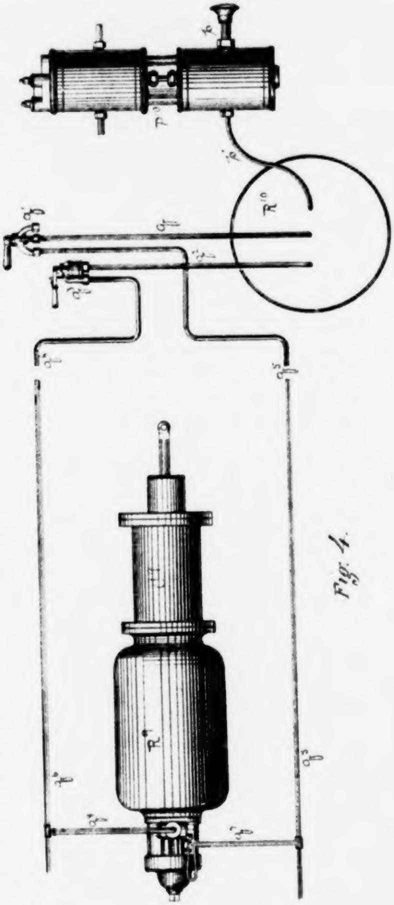


Fig. 4.

Witnesses
R H Whittlesey
C. L. Parker

Inventor George Westinghouse Jr
By Attorney George H. Christy

BLEED THROUGH POOR COPY

structure," one of such structures being applied to each car as a part of the automatic appliances.

In the diagram, Fig. 4, I have shown in outline, but with sufficient clearness for the present purpose, an air-compressing pump, P^{10}, a main reservoir, R^{10}, the air inlet-pipe p, which supplies air to the pumping-cylinder, and the air-pipe p', which leads to the main reservoir. From this main reservoir, usually arranged on the locomotive, two lines of brake-pipe extend back beneath the cars of the train. The one line, q, leads, by the ordinary three-way cock q', to the brake-pipe q^5, which pipe and cock may represent such as are used with the "Westinghouse compressed-air brake," so called, wherein the power is first stored up in the reservoir, and then by manipulation of the cock is allowed to flow back through the brake-pipes when, and only when, it is desired to apply the brakes. In the other line a pipe, q^2, leads to a cock, q^3, such as is used or is adapted for use in working the Westinghouse automatic brake, and from this the brake-pipe q^6 leads back beneath the cars, as before. This line may be called the "automatic line." The usual hose and couplings are to be added between cars, and in other respects (not herein specified) these appliances are to be fitted up in any of the ways known in the art.

The apparatus through which both lines of pipe, q^5 and q^6, are brought into conjoint use is illustrated in all the figures, but more fully in Fig. 1, where R^9 represents the auxiliary reservoir, and C^9 the brake-cylinder, a portion of each being broken away for convenience of illustration. The outer end of the reservoir R^9 has a large open port, R^8, and over this port is secured, by bolting or otherwise, the valve-case A of what is termed in the Westinghouse automatic brake a "triple valve." This triple-valve device has substantially the construction described in United States patent No. 220,556, granted to me October 14, 1879, with more particular reference to Fig. 4 thereof, with the exception that the port there marked C, and here marked C C′, leads by pipe P^8 directly through the auxiliary reservoir R^9 to the brake-cylinder, here marked C^9, though obviously it may pass around outside the auxiliary reservoir,
1262 if so preferred; also, the escape-port there, as here, lettered E, instead of opening into the open air, opens into a branch, q^7, Fig. 4, of the line of brake-pipe q^5; also, the cock K, in addition to the ports k k', has an additional port, z, which opens to the external atmosphere, Figs. 2 and 3.

The construction and operation of devices not herein specifically described will be readily understood by reference to the patent last named, where similar devices have like lettering; but even this reference is unnecessary, as the devices in question are already in extensive public use, and, as such, constitute a part of the art already known to those skilled therein.

With the appliances in their usual or normal condition—that is, with the pipe q^5 free of more than atmospheric pressure, the cock q' closed, the cock q^3 open, so that the pipe q^6, with its branch q^8, and the auxiliary reservoirs R^9 charged with a working fluid-pressure, and the triple valve in the position shown in Fig. 1, the train will

be in running order and the brakes will be off. Each auxiliary reservoir will receive its charge of compressed air from q^8 by the appropriate ports and passages P, k, P′, B, b, B′, a a' a^2, B^2 and R^8. If, now, the engineer wishes to apply the brakes, he shifts his automatic cock q^3 in the usual way, which will result in the lowering of the pressure in the brake-pipe q^6 and chamber B′, cause a back-stroke of the piston G, which will shift the valve H, cut off the port E, and open communication from R^9, through C, k', and C′ and P^8 to the brake-cylinder C^9, so as to apply the brakes with more or less force, according to the amount of the reduction of air-pressure in the pipe q^6.

Thus far the operation varies in no material respect from what is described in the patents above referred to; but it is of great importance in the running of heavy trains down very long and steep gradients that a uniform and easily regulated variable pressure be maintained in the brake-pipes and cylinders, which is sometimes somewhat difficult with the automatic apparatus alone.

By my present invention, instead of exhausting into the open air the fluid-pressure as it escapes from the brake-cylinder when the brakes are partially or wholly released by the "automatic" method of operation, I connect the escape-port E, by the branch q^7, with the pipe q^5, so that the escaping air shall go into and be confined in such pipe. Then, as the brakes are successively applied and released in the automatic operation, the fluid-pressure escaping from the brake-cylinder on each release will be charged into the brake-pipe q^5, and will soon accumulate to, or nearly to, the degree of pressure which the engineer may desire to preserve in his brake-cylinder, and the pipe q^5 and the brake-cylinder being brought into communication on each release, the same degree of pressure, or nearly the same, will soon exist in both. In case such degree of pressure should accidentally or by miscalculation, or in consequence of a change in the speed of the train, or on account of a change of grade, or for other cause, become too great, such operative pressure may be reduced much or little by shifting the cock q' so as to lower the pressure in q^5, and, of course, in the brake-cylinder.

Should operative pressure at any time, for any reason, be too little, it may be increased by working the automatic, as before, or by shifting the cock q' so as to turn on pressure from the main reservoir through the pipe q^5. In this way, through two separate lines of connection, each of which may be brought into action independently of the other, the engineer possesses the most perfect control over his brakes, and through them over his train, on all variations of track, grade, or speed; and it is also a further advantage that while the automatic acts the more quickly, it is possible, by combining the two systems of operation, particularly with engineers unskilled in the accurate use of the automatic, to get more accurate adjustments of brake-power by using the compressed-air system by pipe q^5, for effecting slight variations of pressure after the average or approximately the desired pressure has been attained with the automatic. Also, it has sometimes happened in unskilled hands, or in consequence of injury or imperfect care, that the automatic

brake would not release on the restoration of the pressure in pipe q^6. When this happens the cock K may be turned so as to bring the port z into communication with the port C′, and thereby let the air escape from the brake-cylinder C^9, and so release the brakes. To this end the port z is made lengthwise of the cock, key, or plug, and at its outer end opens to the atmosphere.

I have described the invention as applied to a single set of car equipment; but the apparatus described is merely duplicated on the different cars of the train. It should be stated, however, that the hose-couplings between the cars on the pipe q^5, by preference, have no valves to close their ports when a train pulls in two, and the rear coupling of the last car should be closed by a dummy, special cock, or otherwise.

I claim herein as my invention—

1. The method of combining a compressed-air system of brake apparatus and an automatic system by connecting the brake-pipe of the former with the exhaust-port of the latter, substantially as set forth.

2. A cock, K, having an exhaust-port, z, in combination with the brake-cylinder and exhaust-pipe of an automatic brake apparatus, substantially as set forth.

In testimony whereof I have hereunto set my hand.

GEORGE WESTINGHOUSE, JR.

Witnesses:

R. H. WHITTLESEY.

C. S. PARKER.

1269 UNITED STATES PATENT OFFICE.

GEORGE A. BOYDEN, of Baltimore, Maryland, assignor of one-half to Charles B. Mann, of same place.

Fluid-pressure Brake.

Specification forming part of Letters Patent No. 280,285, dated June 26, 1883. Application filed April 30, 1883. (No model.)

To all whom it may concern:

Be it known that I, George A. Boyden, a citizen of the United States, residing at Baltimore, State of Maryland, have invented certain new and useful improvements in fluid-pressure brakes, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention relates to certain improvements in fluid-pressure brakes for railway-trains, and to an improved method of applying and maintaining the application of the brakes.

The objects of the invention are, first, to provide for replenishing, while the brake is on, the air-reservoir on each car or the brake-cylinder when the pressure therein has been lessened by leakage, and to accomplish this through a single line of train-pipe and by means which shall at all times be wholly under the control of the engineer, and also to provide for the more rapid charging than heretofore of the air-reservoir on the car, and also to obviate the necessity of applying the brakes with such a high pressure as heretofore has been necessary with the automatic brake, the effect of which is to slide the wheels and flatten them; second, to provide for dispensing with the main air-reservoir on or near the locomotive, and thereby simplify and cheapen the apparatus; third, to provide for the quicker release of the brake.

My invention consists, first, in the several combinations, hereinafter specified, with an air-reservoir on the car, of means whereby the said air-reservoir may be replenished or recharged with compressed air while the passages or ports leading therefrom to the brake-cylinder are open and while the brakes are applied; second, in the combination, with an air-reservoir on the car and air-compressing apparatus on the locomotive, of means whereby is afforded the principal advantages of the "automatic" brake system, as well as the direct compressed-air system, without employing the usual main air-reservoir on or near the locomotive; third, in the combination, with an air-reservoir on the car, of a brake-releasing valve, whereby, when the train-pipe contains the maximum fluid-pressure, the brakes will be released quickly; fourth, in a new method of applying and maintaining the application of the brakes through a single line of train-pipe, as hereinafter specified.

(Here follow diagrams marked pp. 1264, 1266, & 1268.)

8007

Nos. 403 & 426.
Westinghouse Co } p 1264
v.
Boyden Co.

(No Model.)

3 Sheets—Sheet 1.

G. A. BOYDEN.

FLUID PRESSURE BRAKE.

No. 280,285.

Patented June 26, 1883.

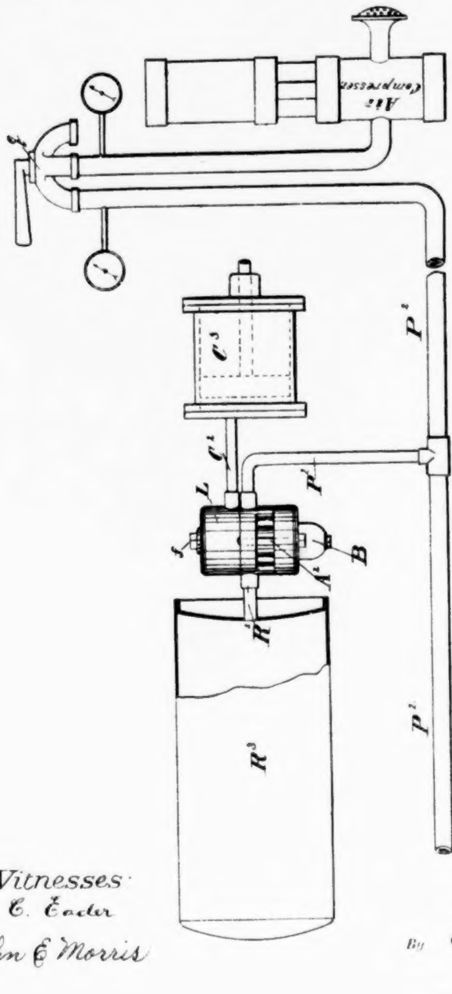


Fig. 1.

Witnesses:
A. E. Eader
John E. Morris

Inventor
Geo. A. Boyden
By Chas. B. Mann
Attorney.

BLEED. THROUGH   POOR COPY

Nos. 403 & 426.
Westinghouse Co. v. Boyden Co. } p. 1266.

(No Model.) 3 Sheets—Sheet 2

G. A. BOYDEN.

FLUID PRESSURE BRAKE.

No. 280.285. Patented June 26, 1883.

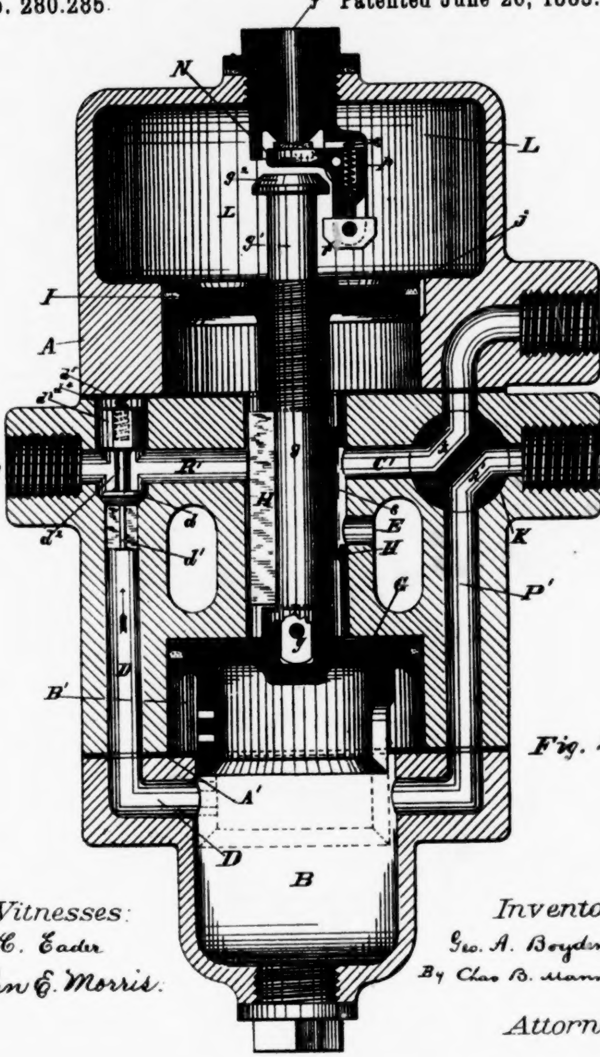


Fig. 2.

Witnesses:
A. C. Eader
John E. Morris.

Inventor
Geo. A. Boyden
By Chas B. Mann
Attorney.

8009

No. 403 8426
Westinghouse Co } p 1268
v
Boyden Co

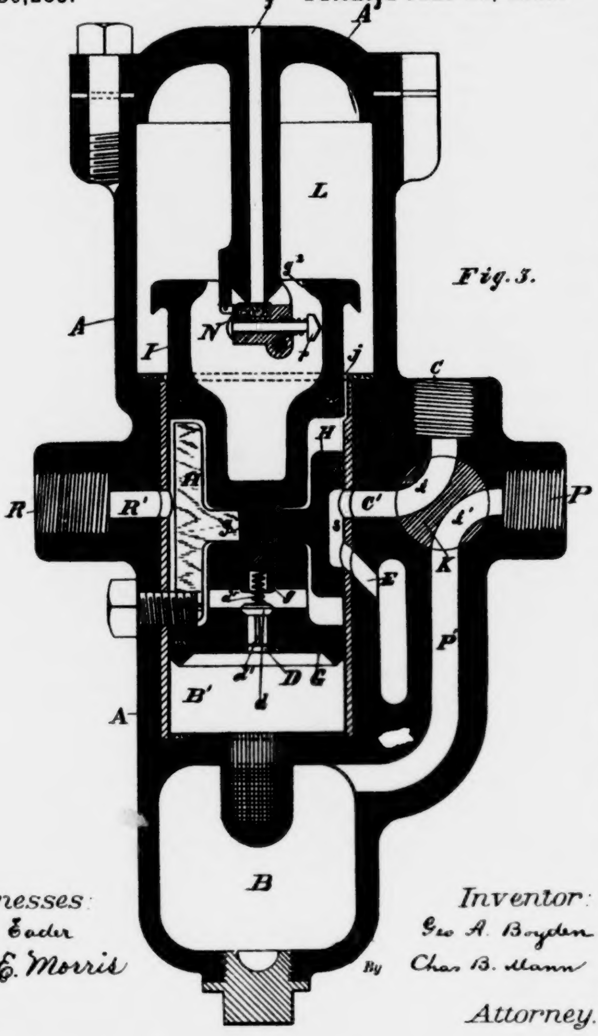
(No Model.)

3 Sheets—Sheet 3.

G. A. BOYDEN.

FLUID PRESSURE BRAKE.

No. 280,285. Patented June 26, 1883.



Witnesses:
A. C. Eader
John E. Morris

Inventor:
Geo A. Boyden
By Chas B. Mann
Attorney.

BLEED THROUGH POOR COPY

Figure 1 is a view of the parts properly assembled of a brake apparatus embodying my invention. Fig. 2 is a sectional view, showing one plan of constructing the valve mechanism and air-cushion chamber. Fig. 3 is a sectional view, showing another plan of constructing the same parts.

The letter A designates the case of the valve; B, the drip-chamber attached at the bottom, (see Fig. 2,) and A′ packing interposed between these parts, which are united by bolts A^2. (See Fig. 1.)

At the port P the train-pipe P^2 is attached. From this port a passage, P′, leads to the drip-chamber B. Adjoining this chamber is a cylinder, B′, fitted with a piston, G, which connects with a slide-valve, H, by means of a stem or rod, *g*. Instead of a slide-valve an ordinary three-way cock may be used. The slide-valve H has a cavity, *s*, long enough to uncover the passage C′ and the exhaust-port E and put them in communication. The passage C′ has outlet at port C, from which the pipe C^2 connects with the brake-cylinder C^3.

At the port R is connected the pipe R^2, which leads to the air-reservoir R^3 on the car. R′ is a passage direct from this port to the valve-chamber.

A four-way cock, K, with ports *k k′*, is arranged in line of the fluid-pressure communication, to provide for operating the brakes of the car by either the automatic system or the direct compressed-air system, according as the train of which the car forms part may happen to be fitted out.

The construction of the parts thus far described may vary or be changed in many ways without materially affecting the operation or result of my improvements, which I will now proceed to describe.

Extending from the drip-chamber is a passage, D, provided with a check-valve, *d*, adapted at all times to allow compressed air from the train-pipe P^2 to reach the air-reservoir on the car, but preventing its return therefrom, whereby no loss of fluid-pressure
1270 from reservoir R^3 can occur in case of accidental separation of
the car from the train, and serving also, as hereinafter explained, to allow compressed air from the train-pipe to reach the brake cylinder C^3 while the brake is applied. As the fluid-pressure can take but one direction in this passage, I call it "an always-open one-way passage." A passage substantially like this, always open for fluid-pressure to reach the air-reservoir on the car, constitutes one feature of my invention.

The check-valve *d* may be constructed in any suitable manner. In the present case it has crossed wings *d′*, which fit in the passage and adapt it to slide like a piston, so that the valve may leave its seat. In Fig. 2 a shank or rod, d^2, projects from the valve, and has attached a head, d^3, which fits in a cylinder or bore, d^4. A spiral-spring, d^5, bears on the head in such manner as to keep the check-valve normally to its seat. At the other end of the piston stem or rod *g*, and connected thereto, is a second piston, I, fitting and arranged to move in a cylinder provided with a port, *j*, adapted to be closed when the piston is in one position and to be opened when the piston is in another. This port connects with an air-cushion

chamber, L. This air-cushion, or its equivalent, constitutes a feature of my invention. The air-cushion chamber L may be constructed without any opening, port, or valve whatever other than the one *j*, which is opened and closed by the piston I. This air-cushion chamber is employed to receive compressed air transmitted through the train-pipe at the maximum pressure. When the brakes are off, the piston I is in the position shown, and the fluid-pressure in the air-cushion chamber, which is on the outer side of the piston, is the same as the pressure on the inner side of the piston; but when the fluid-pressure in the train-pipe P^2 is reduced, such reduction of course is felt on the inner side of the piston, and thereupon the maximum pressure existing in the air-cushion chamber presses the piston I back, and through the stem *g* shifts the slide-valve H, closing the exhaust-port E and opening direct communication between the air-passage R′ and the brake-cylinder passage C′, thereby applying the brakes. It will thus be seen the first effect produced by the fluid-pressure in the air-cushion chamber is to shift the valve H, which applies the brakes. Heretofore in the Westinghouse brake the shifting of the valve has been effected wholly by the back action of the fluid-pressure in the auxiliary air-reservoir. Now, after a lessening of the fluid-pressure in the reservoir on the car or brake-cylinder, by leakage, has occurred, the maximum pressure in the chamber L has the further effect to act as an air-cushion to hold the valve H in the same position while the engineer manipulates the cock *q* on the locomotive to allow compressed air from the compressing apparatus to be transmitted through the always-open one-way-only passage D under a less pressure than the maximum, or less than that in the chamber L, to recharge and to continue charging the reservoir and brake-cylinder while the brakes are applied. This is a new and an important achievement through a single line of train-pipe, and enables me to dispense with the customary main air-reservoir on or near the locomotive, and constitutes a new method of maintaining the application of the brakes after they have been applied, and is a feature of my present invention. As long as the recharging is continued with the fluid under a less pressure than the maximum, or less than that in the chamber L, there will be no relaxation of the grip of the brake-shoes on the wheels.

Instead of a piston, I, for the fluid-pressure in the air-cushion chamber L to press against, a flexible or elastic diaphragm with suitable valves might be substituted. So far as concerns the air-cushion, of which the piston I is a part or necessary adjunct, I include as within my invention all known equivalents for the piston which will operate substantially as herein set forth.

It has been stated that the air-cushion chamber may be constructed without other opening, port, or valve than that which is opened and closed by the piston I; but in the present instance a valve, N, is provided in the said chamber, and its use effects the quick release of the brake, and the same constitutes another feature of my invention. This brake-releasing valve consists, as shown in Fig. 2, of the escape-port *f*, a right-angled lever, P, one arm of which

carries the valve N, which closes the escape-port, and the other arm of which carries a pivoted trigger, r. This arm is adapted to move laterally. When pressed down at one side, the trigger will yield, but when pressed upward on the same side it is unyielding. A spring, s, is arranged to keep the trigger normally in a given position. The piston-stem g has its upper end, g', projecting past the piston I and into the air-cushion chamber. A head, g^2, is on the projecting end.

From this description of the drawing it will now be understood that when on applying the brakes the piston I is pressed back by the maximum fluid-pressure in the chamber L the trigger r will yield as the head g^2 on the stem passes down, thereby allowing the head to pass. When the maximum fluid-pressure is transmitted from the compressing apparatus on the locomotive to release the brakes, the pistons and stems are forced up; but their upward movement now would ordinarily be tardy, because of the resistance of the air-cushion, and hence the brake now would be released slowly. This tardy release of the brake is a difficulty also sometimes experienced in the Westinghouse automatic brake on account of the resistance of the air in the auxiliary reservoir. To remedy this therefore, when the stem starts on its upward movement the head g^2 at once comes in contact with the trigger r, which, not yielding,
1271 causes one arm P of the lever to move laterally, thereby removing the valve N from its seat over the escape-port and instantly allowing the fluid-pressure in the chamber to exhaust. There being then no longer any resistance, the brakes will be released instantly.

To charge the brake apparatus with fluid-pressure, compressed air from the compressing apparatus is transmitted through the train-pipe, and then direct through the always-open one-way passage to the air-reservoir. In charging as here described the circuitous and smaller passages or ports of the Westinghouse triple valve heretofore used are avoided. The fluid-pressure thus transmitted from the compressing apparatus, coming against the pistons G and I, forces them up, thereby closing the brake-cylinder passage C′ and opening the port j, which allows the maximum fluid-pressure to enter the air-cushion chamber L. The same pressure at the outset will therefore exist on both sides of the piston I. Now, to apply the brakes, the engineer by slightly opening the cock q reduces the pressure in the train-pipe below the maximum stored in the air-cushion chamber, whereupon the effect is to press the pistons I G down, thus allowing the fluid-pressure in the reservoir R^3 to pass through passages R′ and C′ into the brake-cylinder and apply the brakes. When through a lessening of the fluid-pressure by leakage it is desired to replenish or recharge the brake-cylinder without either releasing the brakes or relaxing the grip of the shoes on the wheels, the engineer may manipulate the cock q to transmit air under a less pressure than that stored up in the air-cushion chamber. By this method a constant supply of fluid-pressure is maintained in the air-reservoir on the car, and there is no longer need for a main air-reservoir on the locomotive, as heretofore.

In Fig. 3 the always-open one-way passage D and check-valve *d* is shown through the piston G instead of entirely at one side, as in Fig. 2. The case A, drip-chamber B, and air-cushion chamber L are here shown united in a single casting instead of being composed of three pieces, as in Fig. 2. A cap, A^3, is bolted over and constitutes the top of the air-cushion chamber. As shown in this figure, the device can be more cheaply constructed.

As already explained, the form, and to some extent the arrangement of the valves, ports, and passages, may be varied or changed without materially affecting the operation of the parts herein combined, and I hereby include such modifications as within the scope of my invention. I also include herein as an equivalent for the air-cushion chamber any substitute—such as a spring—which may be compressed by the maximum fluid-pressure, and then, when such pressure is reduced to apply the brake, will, like the air-cushion, hold the valve H while the brake-cylinder is replenished or recharged. Any such equivalent or substitute as produces substantially a like operation or result I here include as of my invention.

While the several novel features—to wit, air-cushion chamber L, the release-valve N, and the always-open one-way-only passage D—are adapted and specially designed for use without reference to and independent of a main air-reservoir on the locomotive, and are so shown here, said features may nevertheless be used, with all their resulting advantages unimpaired, in connection with a main air-storage reservoir on the locomotive, as now employed by the Westinghouse system of automatic brakes. Therefore my claims hereinafter given apply and cover said features in both said systems. In the event of the accidental separation of the cars of a train, the brakes will at once be applied as in the automatic brake-system.

By my improvements very important results are attained—to wit, a brake is provided which affords the principal advantages of the automatic system, as well as the principal advantages of the "direct" compressed-air system, without the disadvantages or difficulties heretofore experienced in either.

Having described my invention, I claim and desire to secure by letters patent of the United States—

1. In fluid-pressure brakes, the combination, with the train-pipe and an air-reservoir on the car, of a passage between the two always open one way only adapted at all times to allow fluid-pressure to enter the air-reservoir, substantially as set forth.

2. In fluid-pressure brakes, the combination, with a brake-cylinder, an air-reservoir on the car, and valve mechanism to open and close connection between the cylinder and reservoir, of means, substantially as described, whereby the brake-cylinder may be directly recharged with fluid-pressure from a single line of train-pipe while the brakes are applied, as set forth.

3. In fluid-pressure brakes, the combination, with a brake-cylinder, an air-reservoir on the car, and valve mechanism to open and close connection between these two, of an air-cushion chamber provided with means by which air compressed in the chamber will hold the

valve mechanism to maintain communication between the reservoir and cylinder, substantially as set forth.

4. In a fluid-pressure brake, the combination of a brake-cylinder, an air-reservoir on the car, valve mechanism to open and close connection between the cylinder and reservoir, means, substantially as described, to hold the valve mechanism, air compressing apparatus on the locomotive, and train-pipe to connect directly between the air-compressing apparatus and the said appliances on the car, whereby the usual main air-reservoir on or near the locomotive is dispensed with, as set forth.

5. In a fluid-pressure brake, the combination of a brake-cylinder, an air-reservoir on the car, valve mechanism to open and close connection between the cylinder and reservoir, means, substantially as described, to hold the valve mechanism and a passage
1272 always open one way only to allow fluid pressure from the train-pipe to enter the brake-cylinder while the brakes are applied, as set forth.

6. In fluid-pressure brakes, the combination, with the valve mechanism which opens and closes communication between the brake-cylinder and air-reservoir, of a brake-releasing valve adapted, when fluid-pressure is applied in the train-pipe, to release the pressure back of the valve mechanism, substantially as set forth.

7. In fluid-pressure brakes, the method of applying and maintaining the application of the brakes through a single line of train-pipe, consisting of first applying the brakes by the admission to the brake-cylinder of the fluid-pressure in the air-reservoir on the car, and then maintaining the application of the brakes by the admission to the brake-cylinder of fluid-pressure directly from the air-compressing apparatus on the locomotive, as set forth.

8. In fluid-pressure brakes, the method of applying and maintaining the application of the brakes through a single line of train-pipe, consisting of compressing air and transmitting the maximum pressure to the air-reservoir on the car, applying the brakes from the air-reservoir by reducing the pressure in the train-pipe, and then, when through a lessening of the pressure by leakage it is desired to recharge, transmitting through the train-pipe compressed air under a less pressure than the maximum, as set forth.

In testimony whereof I affix my signature in presence of two witnesses.

GEO. A. BOYDEN.

Witnesses:
J. EDWARD MORRIS.
JNO. T. MADDOX.

1279 UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., of Pittsburg, Pennsylvania.

Fluid-pressure Automatic-brake Mechanism.

Specification forming part of Letters Patent No. 360,070, dated March 29, 1887.

Application filed November 19, 1886. Serial No. 219,353. (Model.)

To all whom it may concern:

Be it known that I, George Westinghouse, Jr., residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, a citizen of the United States, have invented or discovered certain new and useful improvements in fluid-pressure automatic-brake mechanism, of which improvements the following is a specification.

The object of my invention is to enable the application of brake-shoes to car-wheels by fluid pressure to be effected with greater rapidity and effectiveness than heretofore, more particularly in trains of considerable length, as well as to economize compressed air in the operation of braking by utilizing in the brake-cylinders the greater portion of the volume of air which in former practice was directly discharged into the atmosphere.

To this end my invention, generally stated, consists in a novel combination of a brake-pipe, an auxiliary reservoir, a brake-cylinder, and a "triple-valve" device governing, primarily, communication between the auxiliary reservoir and the brake-cylinder, and, secondarily, communication directly from the brake-pipe to the brake-cylinder.

The improvements claimed are hereinafter fully set forth.

In the application of the Westinghouse automatic brake as heretofore and at present commonly in use, each car is provided with a main air-pipe, an auxiliary reservoir, a brake-cylinder, and a triple valve, the triple valve having three connections—to wit, one to the main air-brake pipe, one to the auxiliary reservoir, and one to the brake-cylinder. The main air-pipe has a stop-cock at or near each of its ends, to be opened or closed as required, and is fitted with flexible connections and couplings for connecting the pipes from car to car of a train, so as to form a continuous line for the transmission of compressed air from a main reservoir supplied by an air-pump on the engine. When the brakes are off or released, but in readiness for action upon the wheels of the train, the air which fills the main reservoir and main air-pipes has a pressure of from sixty-five to seventy-five pounds to the square inch, and by reason of the connections referred to the same pressure is exerted in the casings of the triple valves on both sides of their pistons and in the auxiliary reservoirs connected therewith. At the same time passages called "release-ports" are open from the brake-cylinders to the atmosphere. When it is desired to apply the brakes, air is allowed to escape from

Nos. 403 & 426.
Westinghouse Co } p 1274.
v
Boyden Co

(Model.)

3 Sheets—Sheet 1.

G. WESTINGHOUSE, Jr.

FLUID PRESSURE AUTOMATIC BRAKE MECHANISM.

No. 360,070. Patented Mar. 29, 1887.

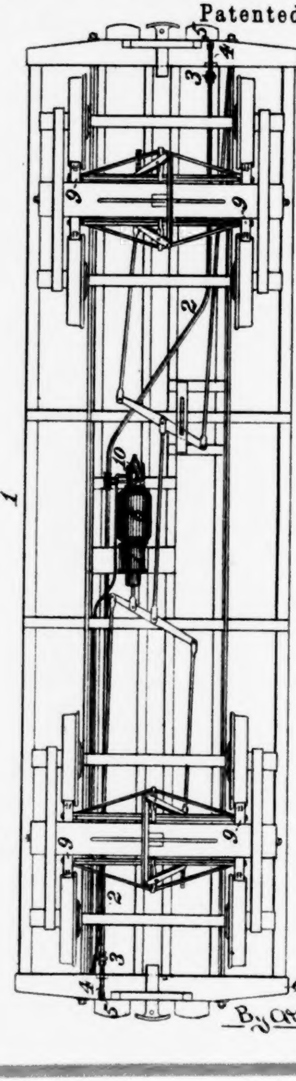


Fig. 1.

Witnesses
R. W. Whittlesey
C. M. Clarke.

Inventor
George Westinghouse Jr
By Attorney J. Snowden Bell

8014

BLEED. THROUGH POOR COPY

No. 403 r426.
Westinghouse Co } p 1278
Boyden Co

(Model.)

3 Sheets—Sheet 3.

G. WESTINGHOUSE, Jr.

FLUID PRESSURE AUTOMATIC BRAKE MECHANISM.

No. 360,070. Patented Mar. 29, 1887.

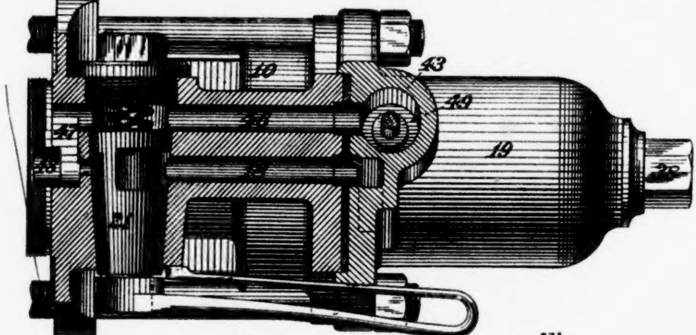


Fig. 5.

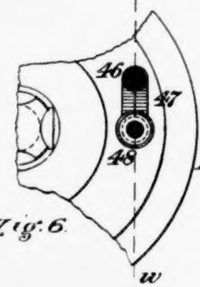


Fig. 6.

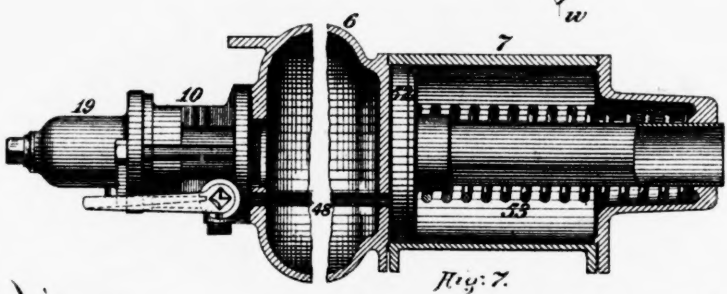


Fig. 7.

Witnesses
R H Whittlesey
C. M. Clarke

Inventor George Westinghouse Jr
By Attorney J. Snowden Bell

the main air-pipes through the engineer's valve, thereby reducing the pressure in the main air-pipes, whereupon the then higher pressure in the auxiliary reservoirs moves the pistons of the triple valves, so as to first close the passages from the triple valves to the brake-pipe and at the same time close the release-ports of all the brake-cylinders, and then open the passages from the auxiliary reservoirs to the brake-cylinders, the pistons of which are forced out by the compressed air thereby admitted to the brake-cylinders, applying the brakes by means of suitable levers and connections, all of which mechanism is fully shown in various letters patent granted to me.

The application of the brakes with their full force has heretofore required a discharge of air from the main pipe sufficient to reduce the pressure in said pipe below that remaining in the auxiliary reservoir after the brakes have been fully applied, and it has been found that, while the brakes are sufficiently quick in action on comparatively short trains, their action on long trains of from thirty to fifty cars, which are common in freight service under present practice, is in a measure slow, particularly by reason of the fact that all the air required to be discharged from the main pipe to set the brakes must travel from the rear of the train to a single discharge-opening on the engine. This discharge of air at the engine has not only involved a serious loss of time in braking, but also a waste of air. Under my present invention a quicker and more efficient action of the brakes is obtained, and air which has been heretofore wasted in the application of the brakes is almost wholly utilized to act upon the brake-pistons.

In the accompanying drawings—

(Here follow diagrams marked pp. 1274, 1276, & 1278.)

Figure 1 is an inverted plan view of a railroad-car, illustrating the application of my invention; Fig. 2, a longitudinal section, on an enlarged scale, through the triple valve at the line *x x* of Fig. 4; Fig. 3, a transverse section through the same at the line *y y* of Fig. 2; Fig. 4, a bottom plan view of the cap or drain-cup of the
1280 triple valve; Fig. 5, a longitudinal section through the triple valve at the lines *z z* of Fig. 3 and *w w* of Fig. 6; Fig. 6, a partial bottom plan view of the triple valve; and Fig. 7, a longitudinal central section through the brake-cylinder and auxiliary reservoir, with the triple valve in elevation.

In the practice of my invention each railroad car 1 on which it is applied is, as heretofore, provided with a main air-pipe, 2, governed by stop-cocks 3, adjacent to its ends, and having a flexible connection, 4, and coupling 5 at each end, to admit of being coupled to the main air-pipe of the tender or the adjacent car or cars of a train. An auxiliary reservoir, 6, and brake-cylinder 7 are secured in convenient position below the sills of the car, the brake-cylinder having a piston, 52, by the movement of which, through a system of lever-connections, which do not form part of my present invention, the brake-shoes 9 are applied to and released from the wheels of the car, compressed air being supplied to and released from the brake-

cylinder 7 as the pressure in the main air-pipe is reduced or reinstated, respectively, by means of a triple valve, 10, the casing or chest of which communicates with the main air-pipe, the auxiliary reservoir, and the brake-cylinder.

So far as the performance of its preliminary function in ordinary braking is concerned—that is to say, effecting the closure of communication between the main air-pipe and the auxiliary reservoir, and the opening of communication between the auxiliary reservoir and the brake-cylinder in applying the brakes, and the reverse operations in releasing the brakes—the triple valve 10 accords substantially with that set forth in letters patent of the United States No. 220,556, granted and issued to me October 14, 1879, and is not, therefore, saving as to the structural features by which it performs the further function of effecting the direct admission of air from the main air-pipe to the brake-cylinder, as presently to be described, claimed as of my present invention. Certain of its elements devised and employed by me prior thereto will, however, be herein specified, in order to render its construction and operative relation to other members of the brake mechanism fully intelligible.

The case or chest in which the operative mechanism of the triple valve proper, 10, is mounted is fixed under or on the car-body in any convenient position relatively to the auxiliary reservoir 6 and brake-cylinder 7, being in this instance shown as secured directly to one end of the auxiliary reservoir, in line axially therewith and with the brake-cylinder, which is secured to its opposite end. The triple-valve case is fitted at one end with a cylindrical sleeve or bushing, 11, which is bored out truly and forms the chamber of a piston, 12, which is fixed upon a stem, 13, carrying, as in my letters patent No. 220,556, before mentioned, a slide-valve, 14, which controls communication between the auxiliary reservoir and the brake-cylinder, and between the brake-cylinder and release-port 15, respectively. The auxiliary reservoir 6 is continuously in communication with the chamber 11, on one side of the piston 12, through the longitudinal chamber 24 of the case in which the slide-valve 14 moves, and the triple-valve case communicates, by a passage, 16, with the brake-cylinder, and, by a passage, 17, with the main air-pipe 2. The passage 17, leading from the main air-pipe, communicates, by a passage, 18, with the cap or, as it is ordinarily termed, the "drain-cup" 19 of the triple valve, from which passages 20 lead into the piston chamber 11. A four-way cock, 21, controls the passages 16, 17, 18, and a passage, 22, leading to a port, 23, in the face or seat of the slide-valve 14. When in the position shown in the drawings, communication is continuously maintained between the main air-pipe 2 and piston-chamber 11, through the passages 17 and 18, drain-cup 19, and passages 20, and by turning the cock 21, so as to establish communication between the passages 16 and 17, the triple valve and auxiliary reservoir will be cut out from the main air-pipe, and the mechanism can be operated as a non-automatic brake, the admission of air under pressure to the main air-pipe and brake-cylinder effecting, in such case, the application of the brakes.

The entire brake mechanism of the car other than the main air-pipe may be put out of action, when for any reason required, by turning the cock 21 into position to cover the passages 16 and 18, the main air-pipe then serving only for the transmission of air between the portions of the train-line made up by the main air-pipes of the remaining vehicles.

The slide-valve 14 is loosely connected with the stem 13 of the piston 12, and by a pin, 25, extending across the stem and fixed in the side plates of the valve, is prevented from being separated from the stem when removed for examination. It is held up to its seat in the chamber 24 by a spring, 26. The valve partakes in the reciprocating movements of the stem 13, being moved in one or the other direction by a collar, 27, and a shoulder, 28, respectively, on the stem. Said collar and shoulder are located at a distance apart slightly greater than the length of the valve 14, so that a limited degree of traverse of the stem 13 and piston 12 in each direction is effected without imparting movement to the valve. A graduating-valve, 29, secured upon a stem, 30, which is moved by the piston-stem, 13, governs a passage, 31, in the slide-valve 14, said passage communicating by a lateral port, 32, with the valve-chamber 24, and consequently with the auxiliary reservoir. A cavity or passage, 33, is formed on the face of the slide-valve 14, of such length as to establish communication during a portion of the traverse of
1281 the valve between the port 23 of the valve-chamber 24, which is open to the passage 16, leading to the brake-cylinder, and a port, 34, communicating with the relief-port 15.

The construction and relative arrangement of the piston-stem 13, slide-valve 14, and graduating-valve 29 are substantially similar to those of the corresponding parts as heretofore employed by me and exemplified in my letters patent No. 220,556; but under my present invention these are supplemented by a port, 35, leading from the end of the valve adjacent to the opening of the chamber 24, which communicates with the auxiliary reservoir, to the face of the valve, so as, at the limit of traverse of the piston-stem in the application of the brakes, to establish communication directly through said passage between the auxiliary reservoir and the port 23 and passages 22 and 16, leading to the brake-cylinder.

The piston-stem 13 abuts when the stem 13 and piston 12 are moved for the major portion of their traverse toward the drain-cup 19 against a stem, 36, which is fitted to slide freely in line axially with the stem 13 in an open-ended bushing, 37, in the end of the drain-cup 19 adjoining the piston-chamber 11, and in a guide formed in a screw-cap, 38, closing the opposite end of the drain-cup. A spring, 39, surrounding the stem 36 and bearing against the inside of the cap 38 and against a collar, 40, on the stem 36, maintains the latter in the position shown in Fig. 2, except when a sufficient pressure of air is admitted from the auxiliary reservoir to the piston-chamber to overcome the resistance of the spring and effect movement of the piston 12 beyond the point at which its stem 13 comes in contact with the stem 36.

So far as hereinbefore described, the triple valve accords in all

substantial particulars with and is adapted to operate similarly to those of my letters patent Nos. 168,359, 172,064, and 220,556, and, in order that it may perform the further functions requisite in the practice of my present invention, it is provided with certain additional members, which will now be described. For the purpose of effecting the admission of air directly from the main air-pipe 2 to the brake-cylinder 7 when it is desired to apply the brakes with great rapidity and full force, an auxiliary slide-valve, 41, is connected to and moves with the stem 36, said valve working over a face in the bushing 37 between the piston-chamber 11 and drain-cup 19, and governing a port, 42, in said face leading into a chamber, 43, adjoining the same. The valve 41 has lateral wings or plates fitting on each side of the stem 36, between shoulders or collars thereon, and is held thereto, when the stem is removed, between collars or shoulders thereon abutting against its ends, by a pin, 44, in its wings, a spring, 45, acting to hold it to its seat in the bushing 37 when in position. The chamber 43 communicates by a passage, 46, Fig. 5, with a chamber, 47, in the end of the case of the triple valve adjacent to the auxiliary reservoir, from which chamber a passage, 48, leads through the auxiliary reservoir into the brake-cylinder 7. The chamber 43 is further provided with a check-valve, 49, which opens outwardly into and controls the passage of air into the passage 46, said valve being held to its seat by a light spring, 50, and serving to prevent the return of air from the brake-cylinder when the pressure in the main air-pipe is reduced below that in the brake-cylinder, as in the case of the separation of the cars of the train by the breaking of a coupling.

In the operation of the brake mechanism as above described, air from the main reservoir and main air-pipe passes through the passages 17 18, drain-cup 19, and passages 20 into the piston-chamber 11, forcing the piston 12 to the left-hand extremity of its stroke and uncovering a small feeding-groove, 51, in the piston-chamber, through which air passes into the auxiliary reservoir 6 until the pressure in the latter is equal to that in the main air-pipe, the brake-cylinder being meanwhile in communication with the atmosphere through the passages 16 and 22, valve-cavity 33, and ports 23 34, and release-port 15. To apply the brakes in making ordinary stops, a portion of the air is discharged from the main air-pipe by the engineer's valve, thereby correspondingly reducing the pressure in the main air-pipe, whereupon the higher pressure in the auxiliary reservoir moves the piston 12 to the right, covering the feeding-groove 51, and thus preventing the return of air from the auxiliary reservoir to the main air-pipe, the movement of the piston continuing until arrested by the decrease of pressure in the auxiliary reservoir or by the stem 36 and its spring 39. The movement of the slide-valve 14 then closes the port 23, preventing escape of air from the brake-cylinder, and places the passage 31 partly or wholly in communication with the port 33. The small auxiliary valve 29 having been meanwhile unseated by the movement of the piston-stem, compressed air from the auxiliary reservoir passes through the lateral port 32 and passage 31 of the slide-valve 14 and the

passages 22 and 16 of the triple-valve case to the brake-cylinder, forcing out the piston, and, through an appropriate system of levers and connections, applying the brakes. When the pressure in the auxiliary reservoir has in this operation been reduced by expansion into the brake-cylinder until it is slightly below the pressure in the main air-pipe, the pressure on the air-pipe side of the piston 12 forces the piston 12 in the opposite direction until the auxiliary valve 29 closes the passage 31, thereby arresting the further flow of air from the reservoir to the brake-cylinder and holding the brakes with a force proportionate to the reduction of pressure in the brake-pipe. To release the brakes, the pressure in the main air-pipe is increased by admitting air from the main reservoir, whereupon the resultant increase of pressure in the piston-chamber 11 forces the piston 12 back to its original or normal position,
1282 permitting the escape of air from the brake-cylinder 7, the
piston 52 of which is returned to its position by a spring, 53, releasing in its backward movement the brake-shoes 9 from the wheels, and at the same time the auxiliary reservoir is recharged. The admission of air to the brake-cylinder through the passage 31, which is opened just before the piston-stem comes in contact with the graduating-stem, and which corresponds to the feed-passage heretofore employed, suffices for the ordinary requirements of braking in regular service. In the event, however, of its becoming necessary to apply the brakes with great rapidity and with their greatest available force, the engineer, by means of the valve at his command, instantly discharges sufficient air from the front end of the main air-pipe to effect a sudden reduction of pressure of about twenty pounds per square inch therein, whereupon the piston 12 of the triple valve is forced to the extreme limit of its stroke in the direction of the drain-cup 19, carrying with it the stem 36 and auxiliary slide-valve 41, which instantly uncovers the port 42 and discharges air from the main air-pipe through the opening of the check-valve 49 and the passages 46 and 48 to the brake-cylinder, and, each car being provided with one of these devices, it will be seen that they are successively moved with great rapidity, there being practically on a train of fifty cars fifty openings for discharging compressed air from the main pipe, instead of the single opening heretofore commonly used. Not only is there a passage of considerable size opened from the brake-pipe on each car, whereby the pressure is more quickly reduced, but the air so discharged is utilized in the performance of preliminary work, it being found in practice that the air so taken from the pipe will exert a pressure of about twenty-five pounds in the brake-cylinders. When the piston 12 arrives at the extremity of its stroke, as above specified, the supplemental port 35 of the slide-valve 14 is brought into communication with the port 33 and passages 22 and 16, which serves to discharge the reservoir-pressure into the brake-cylinder, thereby augmenting the pressure already exerted in the brake-cylinder by the air admitted from the main air-pipe. Upon the reduction of the pressure in the main air-pipe below that in the brake-cylinders, as by the breaking in two of the train, the check-valve 49 closes communication between

the passages 46 and 18, thereby preventing the return of the air from the brake-cylinder to the main air-pipe. The feed-opening for the admission of air from the auxiliary reservoir to the brake-cylinder is purposely made of comparatively small diameter, it having been determined by experiment that the initial application of the brakes should not be made with maximum force, and this opening may be made of such size as to apply the brakes exactly in accord with the requirements of the most efficient work.

In using the terms "triple valve" and "triple-valve device" I refer to a valve device, however specifically constructed, having a connection with the main air or brake pipe, another with an auxiliary reservoir or chamber for the storage of power, and another with a brake-cylinder or its equivalent for the utilization of the stored power and with a release or discharge passage for releasing the operative power from the brake-cylinder, whether the valves governing these passages or connections are arranged in one or more cases and are moved by a piston or its equivalent or by a series of pistons or their equivalents, there being numerous examples in the art of constructions varying materially in appearance whereby these functions are performed, both in plenum and vacuum brake mechanisms.

While I have herein described my invention as applied in a brake mechanism utilizing air under pressure, such as is in general and approved use, I do not desire to limit myself to brakes so operated, as my improvements are likewise susceptible of application, without variation of principle, in connection with brakes worked by atmospheric pressure.

I am aware that a construction in which "an always-open one-way passage" from the main air-pipe to the brake-cylinder is uncovered by the piston of the triple valve simultaneously with the opening of the passage from the auxiliary reservoir to the brake-cylinder has been heretofore proposed, and such construction, which involves an operation different from that of my invention, I therefore hereby disclaim.

I claim as my invention and desire to secure by letters patent—

1. In a brake mechanism, the combination of a main air-pipe, an auxiliary reservoir, a brake-cylinder, a triple valve, and an auxiliary-valve device, actuated by the piston of the triple valve and independent of the main valve thereof, for admitting air in the application of the brake directly from the main air-pipe to the brake-cylinder, substantially as set forth.

2. In a brake mechanism, the combination of a main air-pipe, an auxiliary reservoir, a brake-cylinder, and a triple valve having a piston whose preliminary traverse admits air from the auxiliary reservoir to the brake-cylinder, and which by a further traverse admits air directly from the main air-pipe to the brake-cylinder, substantially as set forth.

3. In a brake mechanism, the combination of a main air-pipe, an auxiliary reservoir, a brake-cylinder, and a triple valve having a piston whose preliminary traverse admits air from the auxiliary reservoir to the brake-cylinder, and which by a further traverse admits air directly from the main air-pipe to the brake-cylinder and

effects a second admission of air from the auxiliary reservoir to the brake-cylinder, substantially as set forth.

1283 & 1284 4. The combination, in a triple-valve device, of a case or chest, a piston fixed upon a stem and working in a chamber therein, a valve moving with the piston-stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere, respectively, and an auxiliary valve actuated by the piston-stem and controlling communication between passages leading to connections with a main air-pipe and with the brake-cylinder, respectively, substantially as set forth.

5. The combination, in a triple-valve device, of a case or chest, a piston fixed upon a stem and working in a chamber therein, a valve moving with the piston-stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere, respectively, an auxiliary valve, actuated by the piston-stem and controlling communication between passages leading to connections with a main air-pipe and with the brake-cylinder, respectively, and a check or non-return valve interposed between the auxiliary valve and the passage leading therefrom to the brake-cylinder, substantially as set forth.

6. The combination, in a triple-valve device, of a case or chest, a piston fixed upon a stem and working in a chamber therein, a valve moving with the piston-stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere, respectively, an auxiliary stem mounted in the cap of the case in position to be moved longitudinally by the piston-stem in the latter portion of its traverse in the direction required for the application of the brakes, a spring bearing against a collar on the auxiliary stem and against a fixed abutment, and an auxiliary valve connected to the auxiliary stem and controlling communication between passages leading to connections with a main air-pipe and with the brake-cylinder, respectively, substantially as set forth.

7. The combination, in a triple-valve device, of a case or chest, a piston fixed upon a stem and working in a chamber therein, an auxiliary valve actuated by the piston-stem and controlling communication between passages leading to connections with a main air-pipe and with a brake-cylinder, respectively, and a main valve connected to the piston-stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere, respectively, said main valve having a supplemental port or passage which establishes communication between the auxiliary reservoir and brake-cylinder connections at or near the limit of the traverse of the main valve in effecting the application of the brake under maximum pressure, substantially as set forth.

In testimony whereof I have hereunto set my hand.

GEO. WESTINGHOUSE, JR.

Witnesses:

J. SNOWDEN BELL.

R. H. WHITTLESEY.

1293 UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., of Pittsburg, Pennsylvania.

Fluid-pressure Automatic Brake Mechanism.

Specification forming part of Letters Patent No. 376,837, dated January 24, 1888. Application filed October 1, 1887. Serial No. 251,195. (No model.)

To all whom it may concern:

Be it known that I, George Westinghouse, Jr., residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, a citizen of the United States, have invented or discovered certain new and useful improvements in fluid-pressure automatic brake mechanisms, of which improvements the following is a specification.

My present invention relates to appliances of the class exemplified in letters patent of the United States No. 360,070, granted and issued to me under date of March 29, 1887, and its object is to facilitate the application of brakes with great rapidity and full or approximately full force, as from time to time required, by the provision of means whereby the admission of air from the brake-pipe to the brake-cylinders may be effected as directly as practicable and through passages of as large capacity as may be desired.

The improvements claimed are hereinafter fully set forth.

In the accompanying drawings,

(Here follow diagrams marked pp. 1286, 1288, 1290, 1292.)

Figure 1 is an inverted plan-view of a portion of a railroad-car, illustrating the application of my invention; Fig. 2, a longitudinal section, on an enlarged scale, through a valve mechanism embodying my invention at the line *w w* of Fig. 3; Fig. 3, a transverse section through the same at the line *x x* of Fig. 2; Fig. 4, a top view of the main slide-valve; Figs. 5 and 6, transverse sections through the same at the lines *y y* and *z z*, respectively, of Fig. 4; Fig. 7, a longitudinal section through the main slide-valve bushing, taken parallel to the valve-face thereof; Fig. 8, a longitudinal section through a valve mechanism, illustrating a modification of my invention at the line *v v* of Fig. 9; Fig. 9, a transverse section through the same at the line *u u* of Fig. 8; Fig. 10, a similar section through the supplemental valve casing at the line *t t* of Fig. 8; Fig. 11, a view in elevation of the supplemental valve seat; and Fig. 12 a longitudinal central section through a valve mechanism, illustrating a further modification of my invention.

As shown in Figs. 1 to 7, inclusive, my invention is applied in connection with a "triple-valve" device which in general structure and manner of operation, and saving as to the improvements hereinafter described, accords substantially with those set forth in my letters patent No. 220,556, dated October 14, 1879, and No. 360,070,

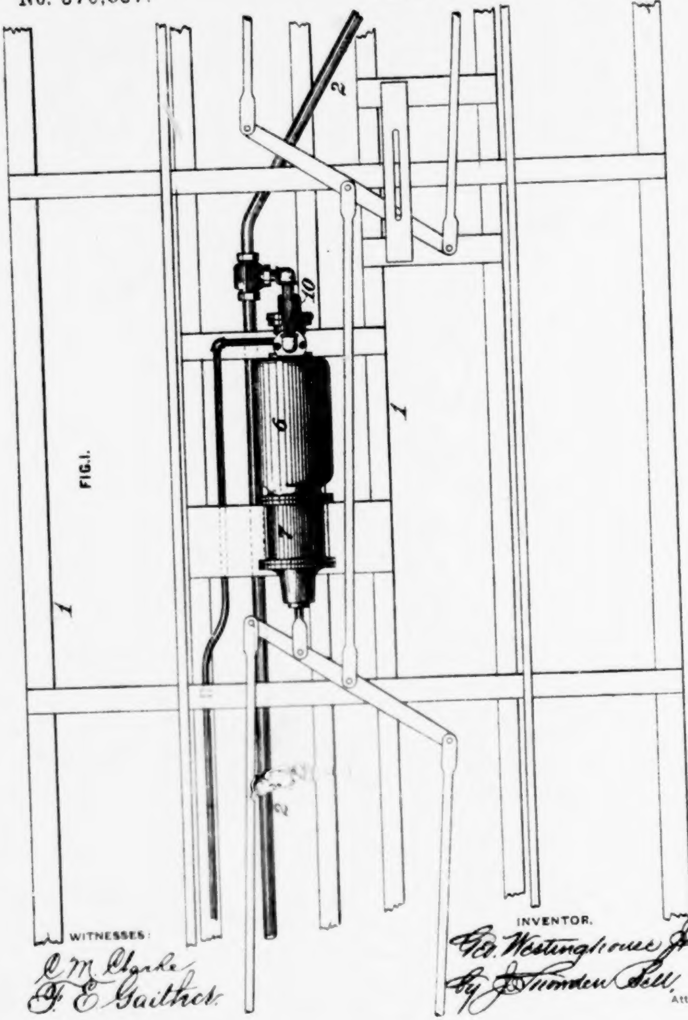
No. 403 & 426.
Westinghouse Co. } p 1286
Boyden Co }

(No Model.) 4 Sheets—Sheet 1.

G. WESTINGHOUSE, Jr.

FLUID PRESSURE AUTOMATIC BRAKE MECHANISM.

No. 376,837. Patented Jan. 24, 1888.



WITNESSES:
C. M. Clarke
F. E. Gaither

INVENTOR.
Geo. Westinghouse Jr
By J. Snowden Bell, Att'y.

BLEED THROUGH POOR COPY

No. 403 & 426.
Westinghouse Co. } p. 1288
Hyde et al.

(No Model.)

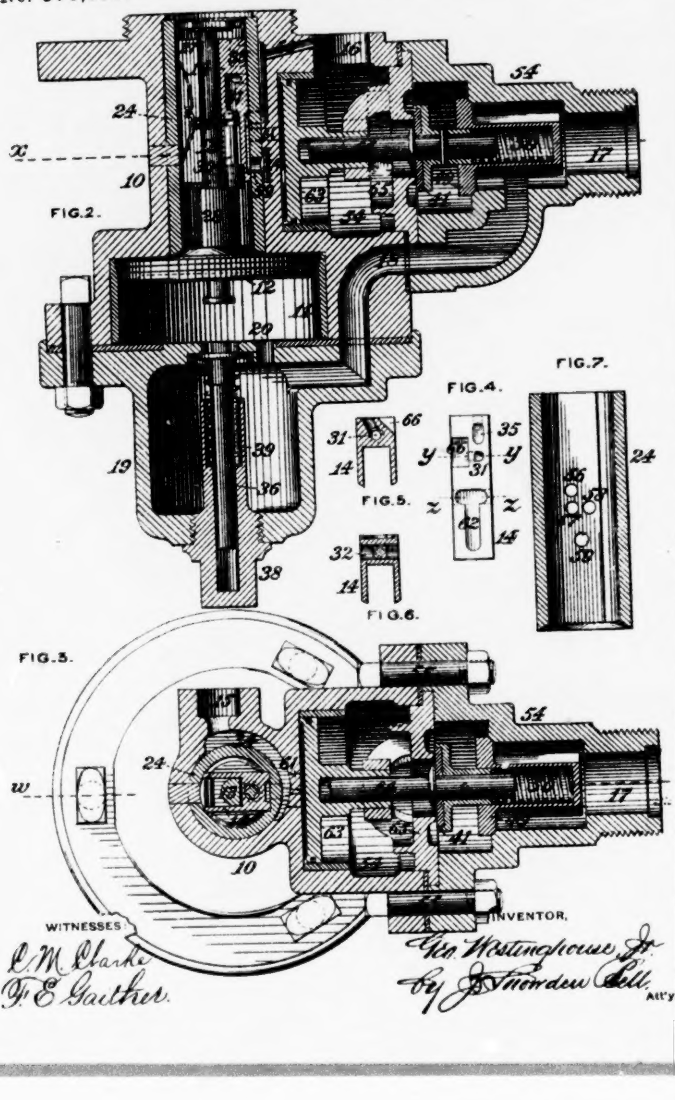
4 Sheets—Sheet 2.

G. WESTINGHOUSE, Jr.

FLUID PRESSURE AUTOMATIC BRAKE MECHANISM.

No. 376,837.

Patented Jan. 24, 1888.



WITNESSES:
C. M. Clarke
F. E. Gaither

INVENTOR.
Geo. Westinghouse Jr.
by J. Snowden Bell. Att'y.

BLEED THROUGH POOR COPY

Nos. 403 & 426
Westinghouse Co } p 1290
Boyden Co

4 Sheets—Sheet 3.

(No Model.)

G. WESTINGHOUSE, Jr.

FLUID PRESSURE AUTOMATIC BRAKE MECHANISM.

No. 376,837. Patented Jan. 24, 1888.

FIG.8.

FIG.10.

FIG.11.

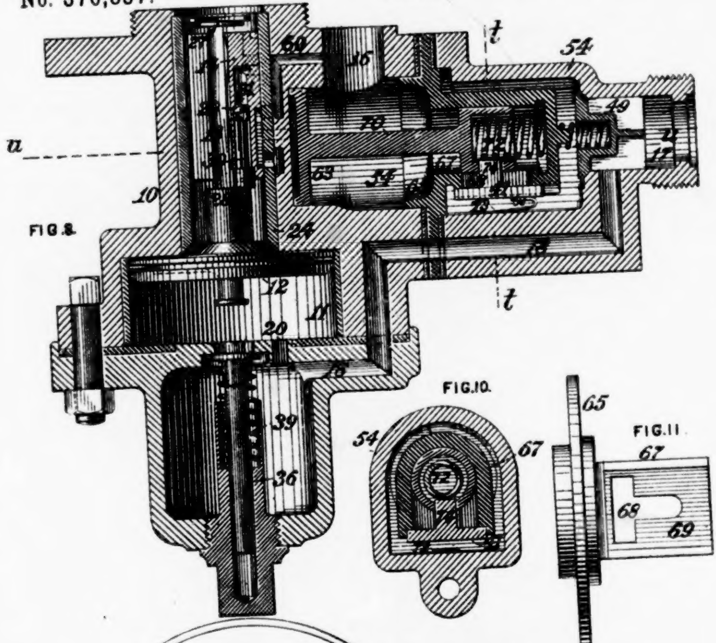
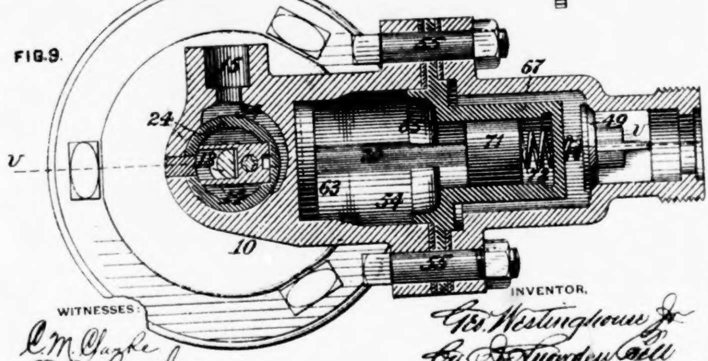


FIG.9.



WITNESSES:

C. M. Clarke
F. E. Gaither.

INVENTOR.

Geo. Westinghouse Jr
By Jos. Snowden Bell
Att'y.

BLEED. THROUGH POOR COPY

No. 403 & 426
Westinghouse Co } p. 1292
Boyden Co.

(No Model.)

4 Sheets—Sheet 4.

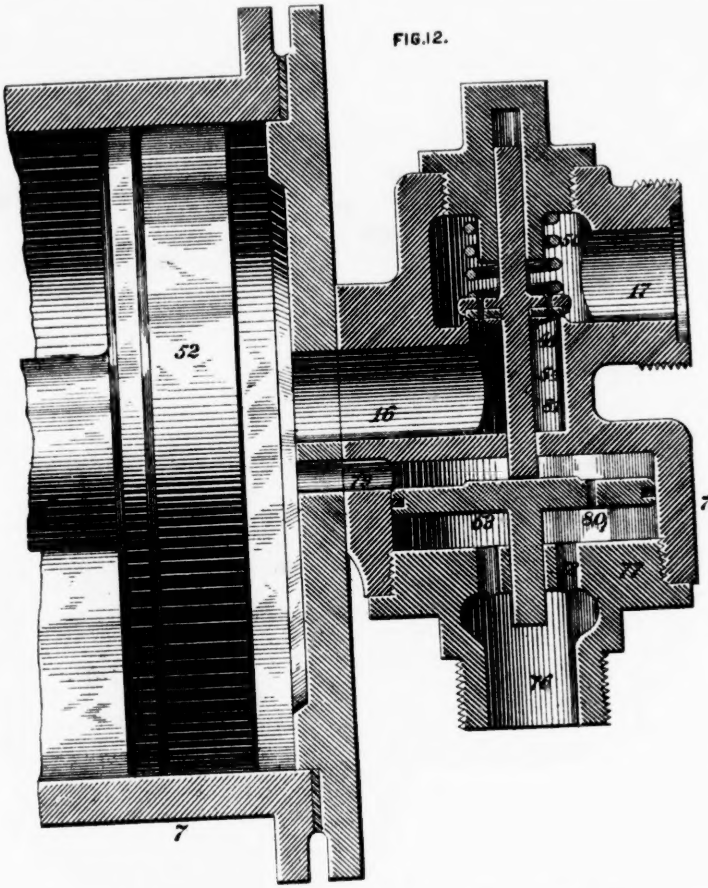
G. WESTINGHOUSE, Jr.

FLUID PRESSURE AUTOMATIC BRAKE MECHANISM.

No. 376,837.

Patented Jan. 24, 1888.

FIG.12.



WITNESSES:
C M Clarke
F. E. Gaither

INVENTOR,
Geo. Westinghouse Jr
by J. Snowden Bell, Att'y.

dated March 29, 1887. The operative mechanism of the triple valve proper is, as in said letters patent, inclosed within a case or chest, 10, which in this instance is secured to one end of the auxiliary reservoir 6, to the opposite end of which the brake-cylinder 7 is connected. The triple-valve case, auxiliary reservoir, and brake-cylinder are fixed in any convenient position on or under the sills or lower framing, 1, of the car, to which the main air or brake pipe 2, having the usual flexible connections and couplings, is likewise secured, and the brake-cylinder is fitted with a piston by the movements of which, through proper lever-connections, the brake-shoes are applied to and released from the wheels of the car.

The portion of the triple-valve case 10 which adjoins the auxiliary reservoir 6 is lined with an open-ended valve-bushing, 24, on which is formed the seat or valve face of the main slide-valve 14, the bushing 24 forming a chamber within which the valve is fitted to reciprocate, said chamber communicating at one end with the auxiliary reservoir and at the other with a bushing 11, forming the chamber of a piston, 12, secured upon the stem 13 of the valve 14. A cap or drain-cup, 19, is secured upon the end of the valve-case 10, in which the bushing 11 is fixed, and communicates with the chamber inclosed by said bushing through a series of ports, 20. A supplemental valve-chamber, 54, is cast upon or secured to the triple-valve case 10 on one side of the valve-bushing 14, said chamber being preferably formed in two sections, as shown, the inner of which is cast upon the triple-valve case and provided with lugs to which the outer or cap section is secured by bolts 55. The chamber 54 communicates by a passage, 17, with the main air or brake pipe 2, and by a passage, 16, with the brake-cylinder 7, communication between the passages 16 and 17 being opened and closed as required in setting and releasing the brakes by interposed valves 41 and 49, as hereinafter described.

The valve-bushing 24 is provided with ports 56, 57, 58, and 59, all of which are governed by the main slide-valve 14. The port 56 communicates with a channel or passage, 60, leading into the
1294 brake-cylinder passage 16. The ports 57 and 58, which are located in line transversely in the bushing, communicate with passages 61, (indicated in dotted lines in Figs. 2 and 3,) leading into the supplemental valve-chamber 54, and the port 59 communicates with a channel, 34, leading to the relief or exhaust port 15. The main slide-valve 14 is provided with a longitudinal passage, 31, extending from its end adjacent to the piston 12 to a point on its face, said passage being governed by a graduating-valve, 29, secured upon a stem, 30, which is fixed to the valve-stem 13 and receives a limited degree of traverse independently of the main slide-valve 14 in order to open and close the passage 31. To this end the collar 27 and shoulder 28 of the valve-stem by which the valve 14 is moved are, as heretofore, set at a distance apart slightly greater than the length of the valve. A lateral port, 32, establishes communication between the valve-face end of the passage 31 and the interior of the bushing 24 and auxiliary reservoir 6 when the graduating-valve 29 is moved off its seat in the passage 31.

A lateral recess or cavity, 66, is formed in the face of the valve 14 adjacent to the opening of the passage 31, in position to register with the port 58 when brought in line therewith in the movements of the valve, and an exhaust recess or cavity, 62, which is widened at one end to extend over the openings of both the ports 57 and 58, is formed in the face of the valve 14 adjoining its opposite end. The exhaust-recess 62 serves in one position of the valve to establish communication between the brake-cylinder and the release-port 15 through the passages 60 and 34, and in another to put the bottom of the supplemental valve-chamber in communication with the release-port through the passages 61, 57, 58, and 59. A supplemental port or passage, 35, leads from the end of the valve 14 adjacent to the auxiliary reservoir to a point on the face of the valve so located that at the limit of the traverse of the valve-stem and valve 14 in the application of the brakes communication will be established between the auxiliary reservoir and the brake-cylinder through the passages 35, 60, and 16.

A supplemental piston, 63, which may be provided with a packing-ring, is fitted to traverse in the end of the supplemental valve-chamber 54 adjacent to the triple-valve case 10, and in its movement outwardly therefrom to bear against the stem 64 of a supplemental valve, 41, which opens outwardly or in the direction of the brake-pipe passage 17, and is seated upon and over an opening in a transverse partition, 65, interposed between the two sections of the valve-chamber 54. A check-valve, 49, which opens inwardly and is seated adjacent to the outer end of the valve-chamber 54, governs communication between the same and the passage 17, leading from the brake-pipe thereto. A spring, 50, bears at its ends upon the stems of the valves 41 and 49, and acts to hold the same to their respective seats during such periods as a substantial equilibrium of pressure is maintained in the brake-cylinder and brake-pipe and when the valve 41 is not subjected to pressure by the piston 63. The check-valve 49 may, if desired, be omitted, the supplemental valve 41 being in such case held to its seat by a spring sufficiently strong to retain within the brake-cylinder a sufficient pressure to stop the train in the event of a rupture of the brake-pipe or of the escape of air therefrom by the train breaking in two.

In operation the application of the brakes under such fraction of the maximum force as is required for making ordinary stops is effected, as in my prior constructions, by discharging a portion of the air from the brake-pipe through the engineer's valve, the preponderance of pressure thereby induced in the auxiliary reservoir moving the piston 12, stem 13, and main slide-valve 14 in the direction of the drain-cup 19 until such movement is arrested by the decrease of pressure in the auxiliary reservoir or by the tension of the spring 39 on the stem 36, against which the stem 13 abuts. The graduating-valve 29 having been meanwhile unseated by the movement of the stem, compressed air from the auxiliary reservoir passes through the port 32, passage 31, passage 60 (with which in this position of the valve 14 the passage 31 communi-

cates,) and passage 16 to the brake-cylinder 6, forcing out the piston thereof and through the usual connections applying the brakes.

In making emergency stops, or when it is desired to apply the brakes with the greatest rapidity and greatest available force, sufficient air is discharged by the engineer to effect a sudden and material reduction of pressure—as, say, twenty pounds per square inch—in the brake-pipe, the effect of which is to force the piston 12 and main slide-valve 14 to the extreme limit of their stroke in the direction of the drain-cup 19. When in such position, the port 58 of the valve-bushing 24 will be opened by the valve-recess 66 and the port 57 by the port 32 and passage 31, permitting the passage of air from the auxiliary reservoir through the ports 57 and 58 and communicating passages 61 to the supplemental valve-chamber 54 on the inner side of its piston 63. The pressure thereby exerted upon the piston 63 forces the latter outwardly, its bearing in its outward movement upon the stem 64 of the supplemental valve 41 raising the latter from its seat, upon which the preponderance of pressure in the brake-pipe and connected passage 17 opens the check-valve 49 and admits air directly from the brake-pipe to the brake-cylinder through the passage 17, chamber 54, and passage 16.

It will be observed that the passages 17 and 16 may be made of as large diameter as desired without interfering with other portions of the mechanism, and that the traverse of the air from the brake-pipe to the brake-cylinder is comparatively short and direct.

When the main slide 14 has been brought into position
1295 to effect the admission of air from the brake-pipe to the brake-cylinder, as above described, its port 35 is in communication with the ports 56 and 60 and the pressure theretofore exerted in the brake-cylinder is augmented by that existing in the auxiliary reservoir, the air from which passes to the brake-cylinder through the ports 35, 56, and 60. Upon the reduction of pressure in the brake-pipe below that in the brake-cylinder the check-valve 49 is seated by the higher pressure on its inner side and by the spring 50, or, if equilibrium of pressure exists in the brake-pipe and brake-cylinder, by the spring 50, thereby preventing the return of air from the brake-cylinder to the brake-pipe.

In releasing the brakes the pressure in the brake-pipe is reinstated by the admission of air from the main reservoir, when the increased pressure, acting through the passage 17 and 18 and openings 20 upon the adjacent side of the piston 12, forces the latter and the connected main slide-valve 14 in the opposite direction, the first effect of which movement is to open the ports 61, 57, and 58 to the release-port 15 through the exhaust-cavity 62 of the valve 14, when the piston 63 is moved inwardly by the pressure upon its outer side, releasing the supplemental valve 41, which, together with the check-valve 49, is seated by the spring 50, thereby closing communication between the brake-pipe and brake-cylinder. The further movement of the valve 14 opens the passage 60 to the exhaust through the recess 62 and allows the air to escape from the brake-cylinder through said passage and recess, when the piston of the brake-cylinder is returned to its original position by a spring, releasing

the brake-shoes in its backward movement. The auxiliary reservoir is recharged, as heretofore, by air which passes through a small feeding groove in the chamber of the piston 12.

Figs. 8 to 11 show a modification in which a different form of supplemental valve is employed, the same being of the slide instead of the puppet type, as in the case first described. In this instance a central chamber, 67, is formed upon the partition or division plate 65 of the supplemental valve-chamber 54, the chamber 67 being open at its inner end to the section of the chamber 54 which is provided with the brake-cylinder passage 16, and communicating by a lateral port or opening, 68, formed in a valve face or seat, 69, on its side, with the outer section of the chamber 54, or that into which the brake-pipe passage 17 leads. The stem 70 of the piston 63 is prolonged to extend into the chamber 67, and carries a head, 71, fitting therein. A spring, 72, which bears against the head 71 and the end wall of the chamber 67, maintains the piston 63 at the inner extremity of its traverse, except when the piston is moved by the pressure of air admitted through the ports 61, as previously described. The supplemental valve 41 is a flat slide, which works on the valve-face 69, and is held to a proper bearing thereon by a spring, 73. The valve 41 is reciprocated to open and close, as required, the por. 68 by the piston 63, a projection, 74, in the valve, which traverses in a longitudinal extension of the port 68, engaging a recess on the side of the head 71 of the piston-stem 70. A check-valve, 49, which opens inwardly and is seated by a spring, 50, is fitted to seat in the outer end of the chamber 54, and controls communication between the chamber 54 and brake-pipe passage 17. The operation is similar to that first described, the supplemental valve 41 being moved to open the port 68 by the piston 63 on the application of pressure to the latter from the auxiliary reservoir through the ports 57, 58, and 61 in the movement of the main slide-valve 14, and the check-valve 49 being thereupon opened by the pressure of air in the brake-pipe and passage 17 and admitting the same to the chamber 54 and brake-cylinder passage 16.

Another modification of my invention (shown in Fig. 12) is designed for use in connection with the ordinary or any desired form of triple valve for the purpose, as in the previous instances, of effecting quick and powerful action when required. The supply of air from the auxiliary reservoir and triple valve to the brake-cylinder 7 in the application of the brake, and its exhaust from the brake-cylinder in their release, is in this case effected through a piston-chamber, 75, which communicates with the triple valve by a passage, 76, formed on or fixed to its head or end plate, 77, and by ports or openings 78, leading out of said passage and through the head 77. The opposite end of the piston-chamber 75 communicates with the brake cylinder by a passage, 79, and a piston, 63, is fitted to work in the chamber between the ports 78 and passage 79. A port, 80, extends through the piston 63, said port being of a diameter not exceeding that which will suffice to admit and exhaust air to and from the brake-cylinder in ordinary braking—that

is to say, where full braking power is not desired to be exerted—so that in such case the air may pass directly to the piston of the brake-cylinder without moving the piston 63, while the sudden admission of a greater volume of air will impart movement to the piston. A valve-chamber, 54, which is connected or adjacent to the piston-chamber 75, communicates with the brake-cylinder 7 by a passage, 16, and with the main air-brake pipe by a passage, 17, communication between said passages being governed by a supplemental valve, 41, which opens outwardly or in the direction of the brake-pipe passage 17, and is normally seated by a spring, 50. The valve 41 is fixed upon a stem, 81, which extends into the piston-chamber 75 and bears at its end upon the piston thereof. The passage 17 may be provided with an ordinary check-valve
1296 opening inwardly to prevent the return of air from the
brake-cylinder on a diminution of the pressure in the brake-pipe below that in the brake-cylinder.

In ordinary braking, air from the auxiliary reservoir and triple valve passes through the passage 76, ports 78, piston-chamber 75, and ports 80 and 79 into the brake cylinder to effect the application of the brakes, and is similarly discharged to the exhaust in their release. When the brakes are to be applied quickly and with full force, a greater quantity of air is suddenly admitted to the piston-chamber 75, and, not finding sufficient discharge through the port 80, moves the piston 63 in the direction of the valve 41, and through the stem 81, unseats said valve and admits air directly to the brake-cylinder from the brake-pipe through the passages 17 and 16 and chamber 54, as in the instances before described. In the release of the brakes the valve 41 is seated by the spring 50.

I claim as my invention and desire to secure by letters patent—

1. In a brake mechanism, the combination of a chamber or casing having direct connections to a brake-cylinder and to a brake-pipe, respectively, a valve controlling communication between said connections, and a piston or diaphragm which is independent of and unconnected with a triple-valve piston and is actuated by pressure from an auxiliary reservoir in direction to impart opening movement to said valve, substantially as set forth.

2. In a brake mechanism, the combination of a chamber or casing having direct connections to a brake-cylinder and to a brake-pipe, respectively, a valve controlling communication between said connections, a piston or diaphragm which is independent of and unconnected with a triple-valve piston and is actuated by pressure from an auxiliary reservoir in direction to impart opening movement to said valve, and a check or non-return valve controlling communication between said valve and the brake-pipe passage of the chamber, substantially as set forth.

3. In a brake mechanism, the combination, with a triple valve, of a supplemental chamber or casing having passages leading to a brake-cylinder and to a brake-pipe, respectively, a supplemental valve controlling communication between said passages, a supplemental piston operating independently of the triple-valve piston and adapted to impart opening movement to said supplemental

valve, and a passage establishing communication between said supplemental piston and an auxiliary reservoir, substantially as set forth.

4. In a brake mechanism, the combination, with a triple valve, of a supplemental chamber or casing having passages leading to a brake-cylinder and to a brake-pipe, respectively, a supplemental valve controlling communication between said passages, a piston adapted to impart movement to said valve, and a passage establishing communication between said piston and an auxiliary reservoir through the main slide-valve of the triple-valve mechanism, substantially as set forth.

5. In a brake mechanism, the combination of a triple valve having its main slide-valve and valve-bushing provided with ports and passages for the admission and exhaust of air from an auxiliary reservoir to and from a brake-cylinder and to and from a supplemental valve-chamber, a supplemental valve-chamber connected to the slide-valve chamber of the triple valve and having passages leading to the brake-cylinder and to the brake-pipe, respectively, a supplemental valve governing a port or opening in a partition of said chamber between said passages, a piston fitting said chamber above a port leading to the main slide-valve chamber in position to impart movement to the supplemental valve, a check-valve governing the brake-pipe passage of the supplemental valve-chamber, and a spring or springs acting to seat the supplemental and check valves, substantially as set forth.

6. In a brake mechanism, the combination of a triple-valve casing, a supplemental valve-chamber composed of an inner section which is formed integral with the triple-valve casing and a separable outer section, each having a lateral air pipe or passage, and a supplemental valve-seat formed in a division plate or partition interposed between and secured to the two sections of the supplemental valve-chamber, substantially as set forth.

In testimony whereof I have hereunto set my hand.

GEO. WESTINGHOUSE, Jr.

Witnesses:

J. SNOWDEN BELL.
W. D. UPTEGRAFF.

(No Model.) 3 Sheets—Sheet 1.

G. A. BOYDEN.

VALVE FOR AIR BRAKES.

No. 481,134. Patented Aug. 16, 1892.

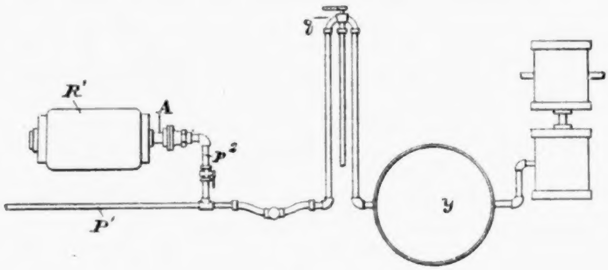


Fig. 1.

Nos. 4030 & 4026.
Westinghouse Co. v. Boyden Co. } p 1298

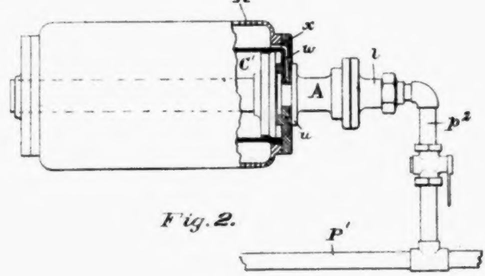


Fig. 2.

Witnesses
A. O. Babendreier.
John E. Morris

Inventor
Geo. A. Boyden
By his Attorney
Chas B. Mann

BLEED THROUGH POOR COPY

(No Model.)

3 Sheets—Sheet 2.

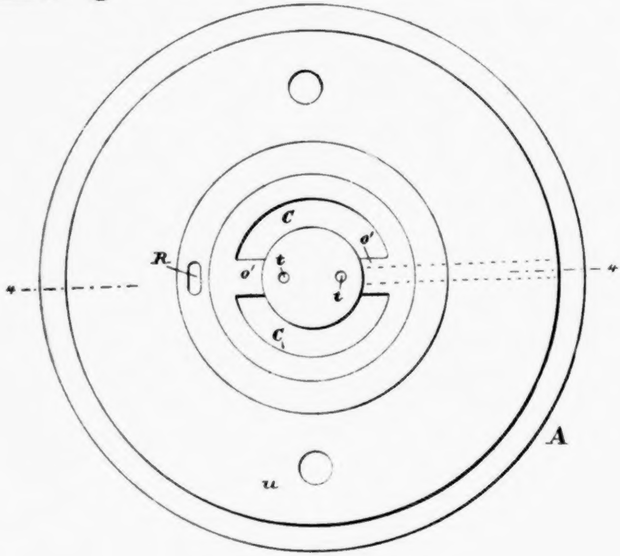
G. A. BOYDEN.

VALVE FOR AIR BRAKES.

No. 481,134. Patented Aug. 16, 1892.

Nos. 403 & 426
Westinghouse Co. } p. 1200
Boyden Co.

Fig. 3.



Witnesses
A. C. Babendreier
John E. Morris.

Inventor
Geo. A. Boyden
By his Attorney
Chas. B. Mann

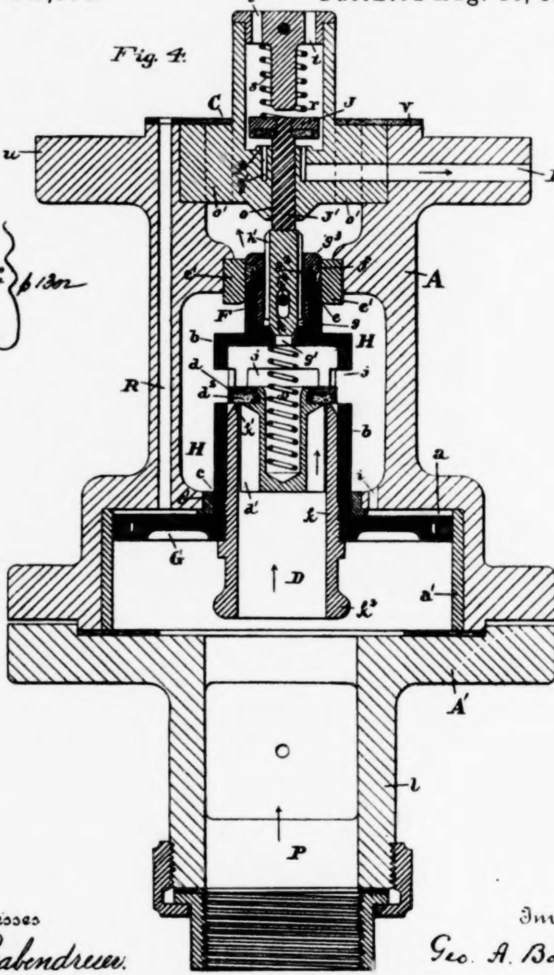
(No Model.) 3 Sheets—Sheet 3.

G. A. BOYDEN.

VALVE FOR AIR BRAKES.

No. 481,134. Patented Aug. 16, 1892.

Fig. 4.



No. 403426
Westinghouse Co. v. Boyden Co. } p 1302

Witnesses
A. O. Babendreier.
John E. Morris.

Inventor
Geo. A. Boyden
By his Attorney
Chas. B. Mann

1303 UNITED STATES PATENT OFFICE.

GEORGE ALBERT BOYDEN, of Baltimore, Maryland, assignor to the Boyden Brake Company of Baltimore City, of Maryland.

Valve for Air-brakes.

Specification forming part of Letters Patent No. 481,134, dated August 16, 1892. Application filed September 30, 1889. Serial No. 325,474. (No model.)

To all whom it may concern:

Be it known that I, George Albert Boyden, a citizen of the United States, residing at Baltimore, in the State of Maryland, have invented certain new and useful improvements in valves for air-brakes; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in valve mechanism of automatic air-brake systems, and has for its principal object to provide for the admission of air-pressure to the brake-cylinder from both the train-pipe and the auxiliary reservoir, so as to affect a powerful application of the brakes, and at the same time produce a reduction of air-pressure in the train-pipe adjacent to the valve mechanism to quicken the application of succeeding brake mechanisms, so that the brakes on all the cars of the train will be applied at nearly the same instant.

In my patent of June 26, 1883, No. 280,285, I brought out an improved triple-valve mechanism having a check-valved passage from the train-pipe so arranged as to admit train-pipe air direct to the brake-cylinder at the same time that auxiliary-reservoir air is in the brake-cylinder. In my present invention I use the check-valved feed-passage of my 1883 patent, leading from the train-pipe through the triple-valve piston to the main valve-chamber, and thence both to the auxiliary reservoir and the brake-cylinder for the double purpose of supplying the auxiliary reservoir and also enabling train-pipe air to be vented directly through the main valve-chamber into the brake-cylinder to aid in applying the brakes in emergency stops.

Referring to the drawings,

(Here follow diagrams marked pp. 1298, 1300, & 1302.)

Figure 1 is an elevation showing the principal elements comprising an ordinary air-brake system and the application thereto of the improved valve mechanism by which the air-pressure is controlled. Fig. 2 is a view illustrating an air-brake cylinder, an auxiliary reservoir, a portion of the train-pipe, and the valve mechanism for controlling the air-pressure in the brake-cylinder,

the same representing the equipment of a single car. Fig. 3 is a view of the valve, looking toward the inner end, which is attached to the brake-cylinder. Fig. 4 is a longitudinal section through the valve mechanism on the line 4 4.

Similar letters of reference in the several figures indicate the same parts.

The brake system in general to which my present improvements are shown applied is that in common use, and includes, in addition to the brake-cylinder C′, auxiliary reservoir R′, and train-pipe P′, (illustrated in Fig. 2,) the usual equipment of the locomotive—such as an air pump or compressor, a storage-tank, and an engineer's valve *q*—all of which parts are familiar to persons skilled in the construction and operation of brake mechanisms.

In addition to the parts named a complete automatic air-brake system includes as one of its essential elements a valve mechanism located on each car and serving to control the admission and escape of air in the brake-cylinder for effecting the application and release of the brakes. This valve mechanism is popularly known as a "triple valve," and the present improvements relate more particularly to this element or part of the brake system and introduces a new mode of operation.

The valve-case shown comprises two pieces, the body part A and the head A′, which are suitably secured together. The open end C of the valve-case is attached in the present instance to the brake-cylinder C′ by bolts passing through flange *u*, with an interposed gasket *v* for making a tight joint. The passage R connects with the auxiliary reservoir R′, the passage P with a branch p^2 of the train-pipe, and the passage E is for the exhaust from the brake-cylinder.

To economize space under the car, the auxiliary reservoir R′ may be placed around the brake-cylinder C′, as shown, instead of being removed or separate therefrom, as is usual, and when so arranged communication is established between the auxiliary reservoir and the improved valve mechanism through a passage *w* in the head *x*
of the brake-cylinder. It will be obvious, however, that it is
1304 not necessary to the operation of my improvements that the
auxiliary reservoir should be thus constructed and arranged, as the usual forms of auxiliary reservoir and brake-cylinder will operate in unison with the improved valve mechanism with equal advantages.

The valve-case is provided with a piston-chamber *a* in open communication with the train-pipe connection or passage P, and in the present instance, this chamber is furnished with a bushing or lining *a′*, within which is fitted a piston G, having a central tubular extension *b* of smaller diameter than the piston and entering the valve-chamber H through an opening *c* at one end. This opening *c* is furnished with a bushing *c′*, which also serves as a guide for the said tubular extension *b*, which projects through it into chamber H. At its end this extension is furnished with a valve F, co-operating with the main valve-port *e* at the end of said chamber. This valve-port is formed by a bushing *e′*. When the port *e* is

open, air may pass from the valve-chamber H to the brake-cylinder C′ by the openings C. The valve F is operated to open and close communication with brake-cylinder C′ from both the auxiliary reservoir R′ and train-pipe P″.

The main valve F is of the kind known as a "plug-valve," and is provided with a suitable packing f to make an air-tight fit in the port through the bushing e'. This valve F has a chamber g, terminating in a small port g', and said chamber is lined by a tube g^2, provided with an end flange g^3 for confining the packing f. The said small port g' serves to establish communication between the valve-chamber H and the brake-cylinder C′ when the main valve F is in its closed position. This small port g' is controlled by the graduating-valve h, which has suitable grooves h' on its sides and fits movably in the lining-tube g^2. The conical end of the graduating-valve h is adapted to fit air-tight over the small port g', and when unseated or moved to uncover the said port compressed air will pass from the valve-chamber H along the grooves h' and then to the brake-cylinder. The stem of the graduating-valve has a cross-slot, through which passes a pin h^2 for limiting the movement of the graduating-valve, and also serving to hold the lining-tube g^2 in position. The end of the stem of the graduating-valve projects beyond the lining-tube g^2, and when the main valve F is entered within the main port e sufficiently far the projecting end of the stem of said graduating-valve engages the stem J′ of the release-valve.

The auxiliary reservoir R′ and piston-chamber a are in communication through the passage R, formed in the valve case. Said passage supplies air on the side of piston G which is opposite the train-pipe passage P. This passage R does not lead through the valve-chamber H. The passage R between the piston-chamber and auxiliary reservoir is larger or of greater capacity than the passage i, through which air from the auxiliary reservoir is admitted to the valve-chamber H. The said passage i, through which auxiliary-reservoir air is conducted to the valve-chamber H in applying the brakes, is smaller—that is, it has a less transverse area and a restricted or smaller conducting capacity—than either the said passage R or the main port e, and it can conveniently be located, as shown, in the partition where the guide-bushing c' is fixed, which partition serves to separate or isolate the auxiliary-reservoir side of the piston-chamber a from the valve-chamber H, and thus makes it possible when applying the brakes in an emergency for the piston G to be subjected on its auxiliary reservoir side to a greater air-pressure than that contained in the valve-chamber H. A passage D is formed through the piston and extends from the train-pipe side of the piston-chamber a to the valve-chamber H, and in said passage is located a check-valve d, which is arranged to allow compressed air to pass from the train-pipe P′ to the auxiliary reservoir R′ for charging, and when the main valve-port e is open from the train-pipe direct to the brake-cylinder for quick action in emergency applications of the brakes; but said check-valve prevents air pass-

BLEED THROUGH POOR COPY

ing from the auxiliary reservoir and brake-cylinder back to train-pipe.

The construction of the check-valve d and its coacting parts may be varied from that shown. In the present instance guide-wings d' are connected to the valve, and the latter carries a packing d^2. The check-valve is recessed, and a spiral spring d^3, seated in said recess, presses the check-valve and keeps it normally on its seat k', and when thus seated communication between the valve-chamber H and the brake-pipe is closed. The check-valve d is located in the tubular extension b of the piston, and passages j in said tubular extension b permit train-pipe air to pass into the valve-chamber H. In the tubular extension an internal tube or lining k is fitted, one end of which serves as a seat k' to the check-valve, while the other end k^2 projects at the opposite side of the piston G and serves as a handle or grasp part. The guide-wings d' of the check-valve slide in the internal tube k.

The check-valved passage D, through which train-pipe air flows when applying the brakes for an emergency stop, has a much greater area or capacity than the small passage i, through which the auxiliary-reservoir air flows. The nozzle l, for connection with the train-pipe P″, is formed on the head A′ of the valve-case, and air under pressure is conducted from the train-pipe through said nozzle.

The exhaust-passage E, through which air is discharged from the brake-cylinder C′ to the atmosphere to release the brakes, is controlled by a release-valve J, having a stem J′, sliding in a bearing o, which latter is supported by bridge-pieces o'. This passage extends through one of the bridge-pieces o', and the openings
1305 C at the sides of said bridge-pieces form supply-passages
communicating with the brake-cylinder. The release-valve J is in line with the graduating and main valves h and F, and these valves are so arranged that when the main valve is fully closed the end of the stem of the graduating-valve presses the stem J′ of the release-valve and lifts the latter from its seat p. This valve-seat p is provided with a port q' in communication with a chamber r on one side and the exhaust-passage E on the other. The release-valve J is located within this chamber r, and the latter is in open communication with the brake-cylinder through passages t. A spiral spring s engages the release-valve and tends to keep it to its seat p.

It is well understood that in valves of this general character a flexible diaphragm may be used as a recognized equivalent of the piston G. This and other equivalent changes may be made without in anywise departing from the present invention. In the present embodiment the valve-case is bolted by its flange to the head of the brake-cylinder in such manner that the passages t, communicating with the exhaust-passage, and the supply-openings C, communicating with the main and graduating valve-ports, will open to the brake-cylinder, while the large passage R is placed in communication with the auxiliary reservoir through a passage w, which in this instance is in the cylinder-head.

The operation of this improved valve mechanism is as follows: To charge the auxiliary reservoir and prepare the brakes for action, compressed air from the train-pipe entering through connecting-nozzle l acts upon the piston G and moves said piston, so that the graduating-valve h and the main valve F will close their respective ports and thus cut off communication with the brake-cylinder C′. The exhaust-valve J will at the same time be moved to uncover its port, and the check-valve d, yielding to the preponderance of pressure exerted on its train-pipe side, will unseat, and air from the train-pipe will be conducted by passages D, j, i, and R to the auxiliary reservoir R′. An approximate equalization of air-pressure will thus be brought about in the auxiliary reservoir R′, valve-chamber H, and train-pipe, and the check-valve will be seated. When it is desired to gradually apply the brakes, the handle of the engineer's valve q will be moved for a moment to such a position that communication between the storage-tank y on the locomotive and the train-pipe P′ will be closed and an escape-orifice opened to the atmosphere. Thereby the air-pressure in the train-pipe will be reduced slightly—say about five pounds or less. This reduction of pressure on the train-pipe side of the piston G disturbs the balance previously existing on opposite sides thereof, resulting in establishing a preponderance of air-pressure on the auxiliary-reservoir side, and the air delivered from the auxiliary reservoir through the passage R and acting upon the piston G causes the latter and its attached parts to move outward and permit the release-valve J to seat, thereby closing communication between the brake-cylinder C′ and the exhaust-passage E. This outward movement of the piston G will continue after the release-valve J has become seated and until the graduating-valve h has been unseated by the pressure of air in the valve-chamber H, thus allowing auxiliary-reservoir air to flow through small p t g' into the brake-cylinder C′, where it acts upon the piston thereof to effect the application of the brakes. When by reason of the flow of air into the brake-cylinder the pressure in valve-chamber H and in auxiliary reservoir R′ has been reduced to or below that in the train-pipe, a slight return or inward movement of the piston G will be produced sufficient to cause the reseating of the graduating-valve h, and thus close communication between valve-chamber H and the brake-cylinder and confine the air admitted within the latter. In case it is desired to gradually increase the air-pressure in the brake-cylinder, the above-described operation is repeated. To permit the air in the brake-cylinder to escape and effect the release of the brakes, the air-pressure in train-pipe is restored or increased by a proper movement of the engineer's valve. The increase of pressure in the train-pipe causes the piston G to move inward to the limit of its stroke, when it will occupy the position illustrated in Fig. 4, thereby raising the release-valve J from its seat and placing the brake-cylinder in communication with the exhaust-passage E and allow the air to escape. At the same time the restoration of pressure in the train-pipe will unseat the check-valve d and air from the train-pipe will flow into the auxiliary reservoir, recharging the latter for future use. The recharging will

continue until the pressure in the auxiliary reservoir equals that in the train-pipe, when the check-valve will be seated by its spring. When it becomes necessary or desirable to apply the brakes of a train quickly and with full power for an emergency stop, the engineer's valve *q* will be moved to close communication between the storage-tank *y* and train-pipe and open the latter to the atmosphere and produce a sudden reduction of pressure of about ten or fifteen pounds in the train-pipe. The effect of this sudden diminution of pressure in the train-pipe is immediately manifested at the nearest valve mechanism or that on the first car, causing the valve-piston G to be moved by the higher pressure of auxiliary-reservoir air quickly to its full outward position, thus moving the main valve F and opening wide the main port *e*, so that the air-pressure contained in the valve-chamber H may exhaust freely into the brake-cylinder. The supply of air from auxiliary reservoir to the valve-chamber H is conducted through the restricted or small passage *i*. Hence when the main port *e* is opened wide and the air in valve-chamber escapes through the larger passage thus
1306 provided the pressure in said valve-chamber is quickly reduced below that in the piston-chamber *a* on the auxiliary-reservoir side. This follows because the passage *i*, supplying auxiliary-reservoir air to the valve-chamber H, is so much smaller than the passage R, supplying the same kind of air to the piston-chamber. The sudden and full opening of the main port *e* allows all or nearly all of the air-pressure on the brake-cylinder side of the check-valve *d* to escape, whereupon the check-valve will be immediately unseated and train pipe air will pass directly into the brake-cylinder C′, thus effecting the quick application of the brakes and also a further reduction of pressure in the train-pipe that will be sufficient to accelerate the action of the valve mechanisms on the cars following. The piston G will in the meantime be held to its outward position by the relatively higher air-pressure from the auxiliary reservoir, which is delivered through the large passage R, while the transmission of auxiliary-reservoir air to the brake-cylinder is retarded by having to pass through the relatively smaller passage *i*. During its preliminary traverse outward or toward the train-pipe side the piston G operates to close the exhaust-passage, and its farther or continued movement in the same direction opens the main valve F and allows air to pass from both the auxiliary reservoir and the train-pipe to the brake-cylinder when making a quick application of the brakes. It will be observed that the valve mechanism depends for its action upon the movements of the piston G and that the latter is subjected to two opposing forces—auxiliary-reservoir air on one side and train-pipe air on the other—and that its movement in one direction is effected by the preponderating pressure of auxiliary-reservoir air, while its movement in the opposite direction results from a preponderance of pressure on the train-pipe side. If the passage *i*, through which auxiliary-reservoir air must flow upon the sudden opening of the main-valve port *e* for an emergency stop, was as large as or larger than the check-valved passage for supplying train-pipe air, the quick action referred to

and the utilization of train-pipe air direct in the brake-cylinder could not be effected for the very obvious reason that the inward flow of train-pipe air at, say, fifty-five or sixty pounds, to the brake-cylinder would be opposed and checked by the flow of auxiliary-reservoir air at a higher pressure, say, seventy pounds; but by restricting the passage through which auxiliary-reservoir air is conducted in the course of its transmission to the brake-cylinder, so that its capacity for the flow of air will be less than that of the main port *e* and less than the check-valve passage leading from the train-pipe, a considerable volume of train-pipe air will flow into the brake-cylinder, notwithstanding the admission of the auxiliary-reservoir air under a higher pressure, because the flow of auxiliary-reservoir air is so retarded by the smaller passage *i*, through which it is conducted, that an appreciable period of time is required to raise the pressure in the brake-cylinder to that in the auxiliary reservoir, and it is during this interval and before the pressure in the brake-cylinder is raised to that in the train-pipe that the air in the latter is free to enter the brake-cylinder. It will thus be seen that the sudden uncovering of the main port or passage *e*, leading to the brake-cylinder, by the movement of the main valve opens communication between the train-pipe and brake-cylinder and also between the auxiliary reservoir and the brake-cylinder; but that the flow of the higher-pressure air from the auxiliary reservoir into the brake-cylinder is retarded by being compelled to traverse a relatively small orifice or passage, while the lower-pressure train-pipe air is permitted to flow through a larger orifice or passage.

From the foregoing explanation it is obvious that there is a co-action at the time of applying the brakes for emergency stops between the restricted passage which supplies auxiliary reservoir air, the larger passage which supplies train-pipe air, and the single valve which controls the communication of air from both of said passages to the brake-cylinder. As soon as the pressure above the check-valve caused by the auxiliary-reservoir air, plus the pressure of the spring d^5, exceeds the pressure exerted by the train-pipe air on the other side, the check-valve will close and the further ingress of train-pipe air to the brake-cylinder will be cut off, while the auxiliary-reservoir air will continue to flow, thus augmenting the pressure therein. To effect the release of the brakes, the air-pressure must be restored in the train-pipe to overcome the pressure on the auxiliary-reservoir side of the piston G, whereupon the parts will act in the manner already described.

As hereinbefore intimated, this valve mechanism belongs to the class of air-brake valves known as "triple valves," of which there are numerous examples, differing somewhat in construction and embodying variations and modifications in the form and arrangement of parts; but all of them, however specially constructed, contemplate a valve structure having suitable connections for the train-pipe, the auxiliary reservoir, and the brake-cylinder, and are provided with passages or ports leading, first, from the train-pipe to the auxiliary reservoir; second, from the said reservoir to the brake-cylinder, and, third, from the brake-cylinder to the atmos-

phere; hence the name triple valve. In some cases a plurality of valves govern these passages or ports.

It is to be observed that some of the distinguishing features of this invention are, first, that provision is made whereby train-pipe air may pass direct to the brake-cylinder through the triple valve, thus utilizing the triple-valve mechanism to effect what is
1307 known as a "quick action" of the brakes without necessi-
tating the use of an "auxiliary" valve, as heretofore; second, quick action of the brakes is produced by the admission of both auxiliary-reservoir air and train-pipe air to the brake-cylinder by use of a single valve and properly proportioning the passages of the triple valve, so that train-pipe air at a lower pressure than that in the auxiliary reservoir may be admitted to the brake-cylinder; third, the novel mode of operation, whereby in applying the quick-action feature three different pressures are momentarily produced in the triple-valve case—that is, the highest pressure on auxiliary-reservoir side of piston, a lower pressure on the train-pipe side of said piston, and the lowest pressure where the port *e* is located, which leads to the brake-cylinder.

In the embodiment shown the main valve of the triple valve is of the reciprocating plug form, which is deemed advantageous, in that it admits of a certain extent of reciprocating movement within its port *e* without opening or uncovering the latter, so that the unintentional slight variations of air-pressure that occur in the train-pipe will be productive of no disadvantage, as the piston G can have a limited movement without allowing any air to pass. Another advantage of this "plug" form of valve is that it permits the closing of the release-valve before the opening of the ports controlled by it and by the graduating-valve. These specific improvements in form, while advantageous in the particulars mentioned, do not affect the new mode of operation due to the reorganization of the triple valve and which results in the addition thereto of a new function. My invention therefore is not limited to this form of valve.

As ordinarily constructed heretofore the triple valve has been arranged to effect two grades of brake application by use of auxiliary-reservoir pressure alone, these two grades differing in degree rather than in kind. The first may be called "full pressure" and the second is known as "graduation." For effecting these two grades of application a main and a graduating valve are employed, corresponding generally, though embodied in different forms, with the main graduating-valves F and *h* here shown. These, together with a release-valve and feeding-valve, are usually arranged to be actuated by a piston.

An example of the class of triple valves just referred to is shown in United States patent to George Westinghouse, Jr., dated October 14, 1879, No. 220,556. Triple valves of this kind and in a great variety of forms are well known; but they do not possess the quick-action principle, which utilizes train-pipe air in the application of the brakes and effects a reduction of train-pipe pressure by

so doing. On the contrary, in such valves the pressure available in the brake-cylinder is derived from the auxiliary reservoir alone.

Efforts have heretofore been made to combine with a triple valve certain additional mechanism by which train-pipe air could be introduced directly into the brake-cylinder in effecting the application of the brakes for emergency stops; but in every such instance a supplemental passage or passages, together with a supplemental or auxiliary valve, has had to be employed in connection with the triple valve proper, in order that the ordinary functions of the triple valve might be preserved and the additional function of introducing train-pipe air into the brake-cylinder for emergency stops be combined therewith.

An example of the class of valves referred to in the last preceding paragraph which employ an auxiliary valve, combined with an ordinary triple valve, is shown in United States patent to George Westinghouse, Jr., dated March 29, 1887, No. 360,070.

It will be seen that my present invention for introducing train-pipe air into the brake-cylinder for emergency stops differs essentially from the device shown in the said patent No. 360,070, because I have provided a new principle of construction and a new mode of operation, by use of which the desired result aforesaid may be produced without the aid of the auxiliary valve heretofore required for the purpose.

An examination of the particular embodiment of the present invention will disclose the fact that it is a triple valve *per se*, without auxiliary or supplemental valve devices, and, further, that its conversion into a quick-action valve and its greater capacity for action over ordinary forms of triple valves is due to means which I have invented for retarding or restricting the flow of auxiliary-reservoir air to the main port or passage leading to the brake-cylinder as compared with the more open or free delivery of train-pipe air to the said main port or passage. By thus delaying or restraining the flow of auxiliary-reservoir air it becomes possible to open both passages to the brake-cylinder, and the difference in size of these passages allows a considerable portion of the air from the train-pipe at lower pressure to enter the brake-cylinder before the air from auxiliary reservoir at higher pressure raises the pressure in the brake-cylinder to such a degree as to prevent the ingress of train-pipe air, and, further, a single valve—the main valve of the triple valve proper—is here made to perform the office of opening communication to the brake-cylinder from both the train-pipe and the auxiliary reservoir in the quick application of the brakes for emergency stops. My invention therefore includes any form of structure of valve wherein a single valve admits both train-pipe air and auxiliary-reservoir air to the brake-cylinder in applying for emergency stops, and which structure is provided with means for restricting or retarding the flow of auxiliary-reservoir air to the brake-cylinder as compared with the flow of the train-pipe air thereto.

1308 The graduating-valve *h* of the present valve mechanism performs the ordinary functions of such a device and is

brought into useful action only in making "graduation" applications of the brakes. It does not affect in any manner the "quick-action" or emergency-stop feature. Hence its presence or absence is not essential thereto.

Having thus explained the principle of my invention and described means by which it may be embodied and practiced, what I claim as new, and desire to secure by letters patent, is—

1. In triple-valve mechanism for automatic air brakes, the combination of a passage from the train-pipe, a passage from the auxiliary reservoir, which is smaller or more restricted than said train-pipe passage, and a single valve coacting with both of said passages and controlling communication between them and the brake-cylinder, whereby when an emergency application of the brakes is desired the train-pipe air and auxiliary-reservoir air, the former at lower pressure than the latter, will both pass to the brake-cylinder through the triple valve.

2. In valve mechanism for automatic air-brakes, the combination of a communication with the brake-cylinder from both the auxiliary-reservoir and train-pipe, a single valve controlling said communication, and means to retard or restrict the flow thereto of the auxiliary-reservoir air when applying the brakes in comparison with the flow of train-pipe air, whereby train-pipe air at lower pressure than said auxiliary-reservoir air will pass said valve when making an emergency application of the brakes.

3. In a triple valve, the combination, with a suitable chamber, of a port therefrom to the brake-cylinder, a valve controlling said port, and passages to the said chamber from the train-pipe and from the auxiliary reservoir, the latter passage being of less capacity than the former, whereby train-pipe air may pass direct to the brake-cylinder through the triple valve to effect quick action of the brakes for emergency stops.

4. In a valve for automatic air-brakes, the combination of a communication with the brake-cylinder, a suitable valve controlling said communication, two air-passages coacting with said valve and relatively proportioned as to their capacity to allow the flow of both train-pipe air and auxiliary-reservoir air each at a different pressure to pass said valve when open, and a check-valve to prevent the return of air to the train-pipe.

5. A valve for controlling automatic air-brakes, having, in combination, a piston which is moved in one direction by pressure from the train-pipe and in the other direction by pressure from the auxiliary reservoir, a valve-chamber which has a check-valved communication from the train-pipe, a communication with the auxiliary reservoir, and a port communicating with the brake-cylinder, said port being of greater area or capacity than the said communication with the auxiliary reservoir, and a valve controlling said port and moved by the piston, whereby when the said port is opened the pressure in the valve-chamber will be reduced momentarily below that in the train-pipe, and air from the latter will thereupon pass to the brake-cylinder.

6. In a triple valve for automatic air-brakes, the combination of

a chamber having a port leading to a brake-cylinder, a passage opening into said chamber and which supplies auxiliary-reservoir air thereto, a piston-chamber and piston, a valve controlling said port and operated by a piston, and a passage from the auxiliary reservoir direct to said piston-chamber and avoiding the chamber first mentioned and which is larger or of greater capacity than the said passage which supplies auxiliary-reservoir air.

7. In valve mechanism for automatic air-brakes, the combination of a piston-chamber, a piston, a valve-chamber having a brake-cylinder port, a passage for supplying auxiliary-reservoir air when applying the brakes, which passage is smaller or of less capacity than said port, a passage to supply train-pipe air when applying the brakes, a valve in the valve-chamber coacting with said port, and controlling the flow of air to a brake-cylinder from both a train-pipe and an auxiliary reservoir, and a passage from the auxiliary reservoir to the said piston-chamber, and which in its course avoids the said valve-chamber.

8. In a triple valve for automatic air-brakes, the combination of a valve-chamber having a port leading to the brake-cylinder, a piston-chamber and piston, a passage from the auxiliary reservoir direct to the piston-chamber and which avoids the said valve-chamber, a passage which is smaller or more restricted than either the said port or the said direct passage to the piston-chamber, this small passage opening into the valve-chamber, and a valve controlling said port and operated by the piston.

9. In a triple valve for automatic air-brakes, the combination of a chamber having a port communicating with the brake-cylinder, a piston-chamber and piston, a passage from the train-pipe to the ported chamber, a partition provided with a passage which is smaller or more restricted than either the said port or the train-pipe passage, said partition serving to partially separate the ported chamber from the said piston-chamber, and a valve moved by said piston and controlling said port, whereby both train-pipe air and auxiliary-reservoir air may pass the same valve-port for an emergency stop.

10. The combination, in valve mechanism for air-brakes, of a piston, valve-chamber having a communication with a brake-cylinder, one from the train-pipe and another through a throttled or more restricted passage from the auxiliary reservoir, a valve to govern the communication leading to the brake-cylinder,
1309 & 1310 a tubular extension of the piston entering the valve-chamber and moving the valve and containing a passage which forms the said communication between the train-pipe and valve-chamber and a check-valve controlling said last-named passage.

11. In valve mechanism for automatic air-brakes, the combination of a main port communicating with a brake-cylinder from both the train-pipe and the auxiliary reservoir, a suitable valve controlling said main port, a graduating-valve which admits air-pressure in small volume to the brake-cylinder, and air-passages coacting with said main port and relatively proportioned as to their capacity to allow both train-pipe air and auxiliary-reservoir air, each at a

different pressure, to pass to said main port when the latter
open.

12. In valve mechanism for automatic air-brakes, the combinat
of a chamber having a main port leading to the brake-cylinde
reciprocating valve of plug form coacting with said main port a
capable of a certain extent of movement without opening the s
port, a graduating-valve *h*, fitting loosely in said plug-valve, an
release-valve unconnected with the said main valve and controlli
an air-escape port.

In testimony whereof I affix my signature in presence of two w
nesses.

GEORGE ALBERT BOYDEN

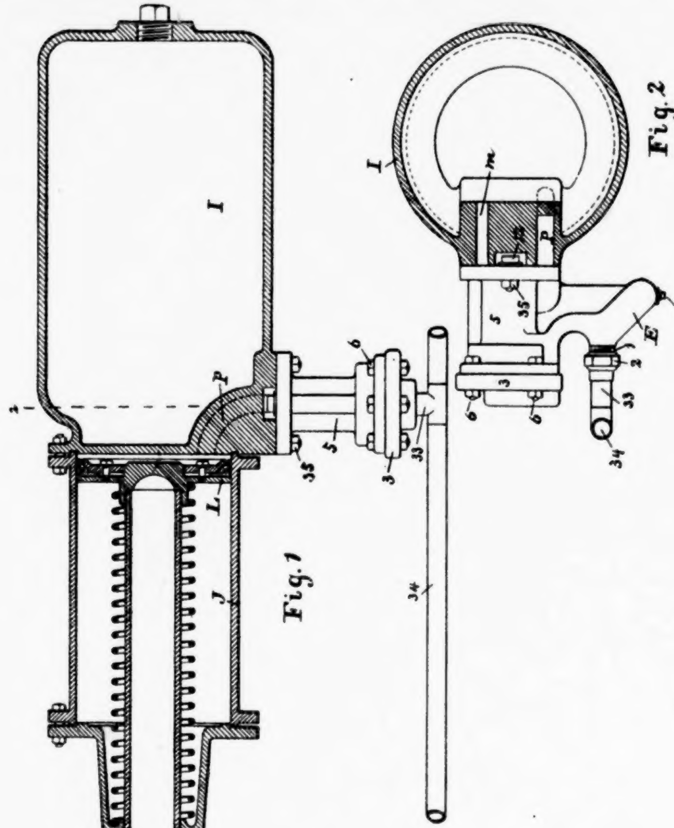
Witnesses:
CHARLES L. SULLIVAN.
JNO. T. MADDOX.

No. 403142 &c.
Westinghouse Co. v. Boyden Co. } p. 1312

(No Model.) 2 Sheets—Sheet 1.

G. A. BOYDEN.
FLUID PRESSURE BRAKE.

No. 481,135 Patented Aug. 16, 1892.



WITNESSES:
J. P. Davis.
Otto H. Ehlers.

INVENTOR:
Geo. A. Boyden

BY Chas B. Mann
ATTORNEY.

(No Model.) 2 Sheets—Sheet 2

G. A. BOYDEN.

FLUID PRESSURE BRAKE.

No. 481,135. Patented Aug. 16, 1892.

Nos. 403 & 426.
Westinghouse Co.
v.
Boyden Co.
p 1314

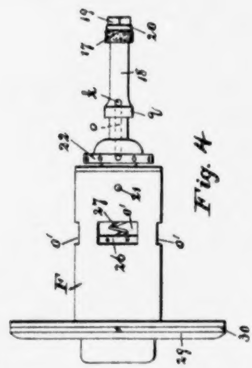


Fig. 4

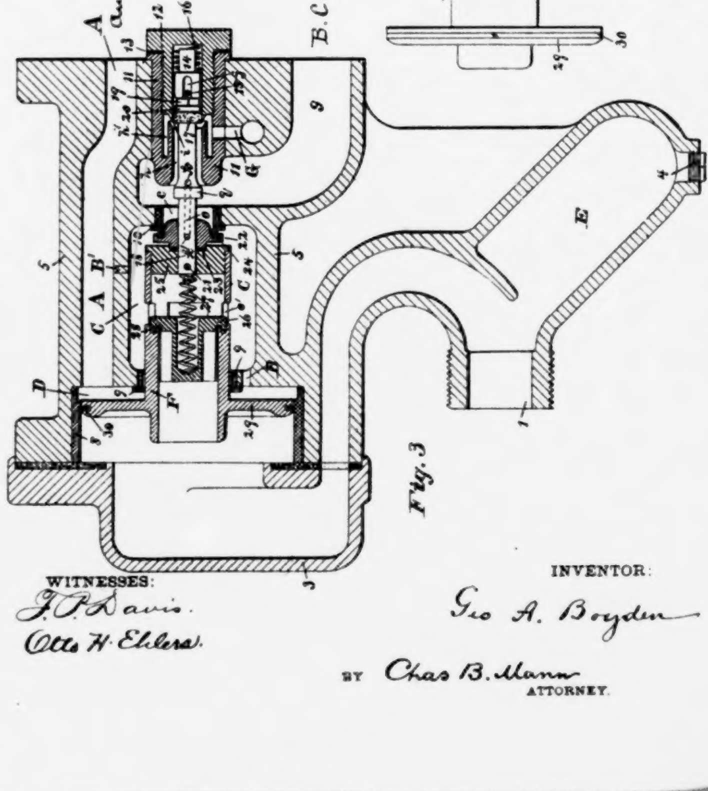


Fig. 3

WITNESSES:
J. P. Davis.
Otto H. Ehlers.

INVENTOR:
Geo A. Boyden

BY Chas B. Mann
ATTORNEY.

1315 UNITED STATES PATENT OFFICE.

GEORGE A. BOYDEN, of Baltimore, Maryland, assignor to the Boyden Brake Company of Baltimore City, of Maryland.

Fluid-pressure Brake.

Specification forming part of Letters Patent No. 481,135, dated August 16, 1892. Application filed March 6, 1891. Serial No. 384,012. (No model.)

To all whom it may concern:

Be it known that I, George A. Boyden, a citizen of the United States, residing at Baltimore, in the State of Maryland, have invented certain new and useful improvements in fluid-pressure brakes, of which the following is a specification.

This invention relates to the construction of valves for automatic air-brakes, and has for its object to provide for admitting air-pressure to the brake-cylinder from both the train-brake pipe and the auxiliary reservoir, thereby effecting a more powerful and also a quicker application of each brake and at the same time so quickly reducing the air-pressure in the train-brake pipe adjacent to the said valves that all the brakes of a train will be applied at nearly the same time.

Referring to the drawings,

(Here follow diagrams marked pp. 1312 & 1314)

Fgure 1 is a section of the auxiliary reservoir and brake-cylinder, with a side view of the valve and train-pipe. Fig. 2 is a cross-section of the reservoir, with a side view of the valve attached thereto, showing the passages by which communication is established between the reservoir and the valve and brake-cylinder. Fig. 3 is a longitudinal section of the valve. Fig. 4 is a side view of the valve-piston and its attached parts.

In my patent of June 26, 1883, No. 280,285, I brought out an improved triple-valve mechanism having a check-valve passage leading from the train-pipe through or around the piston to the main-valve chamber, with a communication to the auxiliary reservoir and a communication to the brake-cylinder, the latter communication being normally covered by the main valve of the triple-valve device and uncovered by the movement thereof, thus utilizing both auxiliary-reservoir air and train pipe air when the brakes are applied. Subsequently George Westinghouse, Jr., for the purpose of utilizing train-pipe air, in addition to auxiliary-reservoir air for applying the brakes in quick action, adopted a check-valved passage leading from the train-pipe around or past the triple valve directly to the brake-cylinder without passing through the main-valve chamber and covered said passage with a valve additional and "auxiliary" to the triple-valve mechanism, said auxiliary valve

BLEED THROUGH POOR COPY

performing none of the three ordinary functions of the latter, but adapted and used solely for producing a "quick action" of the brakes in applying for emergency. The United States patent for the Westinghouse invention here referred to is dated March 29, 1887, and numbered 360,070.

In my present invention I use the check-valved feed-passage of my 1883 patent, leading from the train-pipe through the triple-valve piston to the main-valve chamber, and thence both to the auxiliary reservoir and the brake-cylinder for the double purpose of supplying the auxiliary reservoir, and also enabling train-pipe air to be vented directly through the main-valve chamber into the brake-cylinder to aid in applying the brakes for emergency stops, and this is done without interfering with the usual operation or functions of the "triple valve" and also without the aid of the "auxiliary valve," heretofore required for the purpose. It will be seen that the means I have thus provided for introducing train-pipe air into the brake-cylinder for "emergency stops" differs, essentially, from that shown in said patent No. 360,070, and that said means involves a new mode of operation.

The branch pipe 33 from the train-pipe 34 is connected to the valve by its nozzle 1 and union-nut 2, which screws thereon, the intervening joint between being made tight by a washer. The valve-case is provided with a drip-chamber E, extending below to drain the water therefrom and from which it is drawn off by removing the plug 4. The cap 3 is secured to the body 5 by suitable bolts 6 and the joint between is made tight by a washer. The body-piece 5 of the valve is provided with a cylinder D, lined with a brass bushing 8, a large passage A communicating between the auxiliary reservoir and said piston-cylinder a valve-chamber C, having at one end an opening lined with a brass bushing 9, which serves in part as a partition and separates the piston-chamber D from the valve-chamber C. A small passage B opens in the present instance between the piston-chamber D and the valve-chamber C and forms a communication through which air from the auxiliary reservoir is admitted to the valve-chamber C, and vice versa.
1316 At the opposite end of the valve-chamber is a bushing 10,
forming a port *c*, which is closed by the main valve 22. At this end of the body-piece is a passage *g*, leading to the brake-cylinder, and a bushing 11, having an exhaust-passage G opening to the atmosphere. It is obvious the restricted communication by which auxiliary-reservoir air flows to the valve-chamber may open directly between the auxiliary-reservoir passage A and the valve-chamber, as at B′ in dotted lines. However located, this passage is much smaller than the passage A between the piston-cylinder D and the auxiliary reservoir. The piston 29 is provided with a packing-ring 30 and moves in the cylinder D, according to the changes in the preponderance of the pressure. Integral with the piston is the sleeve F, which fits and moves in the bushing 9. A cap 25 is secured to the sleeve F by the screw 21, which passes crosswise through the cap and also through a stem 18 and has each end resting in the piston-sleeve F.

A bushing 11 is fitted in an opening at the end of the body-piece 5. This bushing has a central passage *h* and an annular passage *h'*. A release-port *i* connects said two passages, and the annular passage has a connection with the exhaust-passage G. A cap 12 fits into the bushing, and a washer 13 makes a tight joint between the cap and bushing. The cap has a central passage, conforming in size to the central passage *h* of the bushing, and is practically a continuation thereof. The release-port *i*, before mentioned, is formed where the inner end of the cap adjoins the annular passage *h'*. In this cap is arranged an abutting piece 14, which has a limited movement by means of a slot *j* and the pin 15. A spring 16 presses against the abutting piece 14 and forms a resistance in graduating to the end of the stem 18 and to the movement of the piston 29 and its attached parts. The release-valve is formed by a leather cup 17, secured to the valve-stem 18 by a screw 19, which extends into the stem, and a washer 20, that binds the said cup. The release-valve is movable like a piston in the central passage *h* of the bushing 11 and cap 12 and opens and closes the release-port *i*. The graduating-valve is formed by the valve-stem 18, having a passage *o*, with an opening *k* at one end, a port *k'* at the other, and with the main valve 22 loose on the said stem 18. The main valve 22 closes the large port *c*, which leads to the brake-cylinder, and this valve seats on the packing-rings 23 and 24. This valve 22 is loose on and is movable lengthwise of the stem 18, which wholly supports it. I term it a "floating" valve because it rides and may move freely on the stem and when unseated from the port *c* is not in contact with any other part. In the piston-sleeve F is arranged in a relation similar to my said 1883 patent the check-valve 26, which is held closed by the spring 27, the seat of the check-valve being formed by the packing-ring 28. The piston-sleeve forms the train-pipe passage and has openings *o'*, which communicate with the valve-chamber C. The partition where the guide-bushing 9 is located isolates or separates the auxiliary-reservoir side of the piston-chamber D from the valve-chamber C, and this makes it possible when fully applying the brakes in an emergency for the piston 29 to be subjected on its auxiliary-reservoir side to a greater air-pressure than that contained in the valve-chamber.

As shown in Fig. 1, the auxiliary reservoir I is attached to the brake-cylinder J, in which moves the piston L. The valve-body 5 is attached to the side of the auxiliary reservoir by the studs and nuts 35, and the large passage A communicates with the auxiliary reservoir I through the passage *m*. Communication between the valve and the brake-cylinder J is established through the curved passage P, connecting with the passage *g* in the valve.

Triple valves heretofore extensively in use, like that patented to George Westinghouse, Jr., October 14, 1879, No. 220,556, have been arranged to effect two grades of brake application by auxiliary-reservoir pressure. The first grade may be called "full pressure," and the second grade, which is partial pressure, is known as "graduation." For effecting these two grades of application a main valve and a graduating-valve have been employed corresponding gener-

ally, though embodied in a different form, with the main and graduating valves 22 and k'. (Here shown.) The graduation-valve k' o k in the stem 18 of the present valve mechanism performs the ordinary functions of such a device and is brought into useful action only in making graduation applications of the brakes. This graduation-valve does not affect the action of the release-valve or the main valve 22, which latter will allow the flow to the brake-cylinder of auxiliary-reservoir air alone, and also allow the flow of both auxiliary-reservoir air and train-pipe air. It will therefore be seen that the presence or absence of the graduation-valve is not essential to the performance by the other parts of all the functions of a triple valve.

The operation of the valve is as follows: To charge the auxiliary reservoir, the air from the train-pipe passes in through the nozzle 1 and moves the valve-piston 29 to the position shown in Fig. 3, where the graduating-valve port k' and the main-valve port c will be closed, and thus all communication with the brake-cylinder cut off. The air then opens the check-valve 26 and passes through the openings o' in the sleeve F to the valve-chamber C, from which it passes through the small passage B into the piston-cylinder D, and thence through the large passage A to the auxiliary reservoir. An
equalization of air-pressure will thus be brought about in the
1317 auxiliary reservoir I, valve-chamber C, and train-pipe, and
the check-valve 26 will be seated.

To apply the brakes by graduation, a slight reduction of the pressure in the train-pipe moves the piston 29 and its attached parts until the shoulder q on the stem 18 comes against the main valve 22, (the main valve remaining immovable on its seat, owing to the air-pressure in the valve-chamber C holding it thereon.) This movement closes the release-valve port i and draws the graduating stem 18 through the main valve 22 sufficiently far to expose the graduating-port k' in the valve-stem to the air-pressure in the valve-chamber C. The air then passes from the auxiliary reservoir by way of the large passage A and small passage B into the valve-chamber C, and then through the graduating-port k' passage o, and opening k in the valve-stem and the passage g to the brake-cylinder, where it effects the partial application of the brakes. This operation, which does not open the main-valve port, is due to the fact that the restricted communication B, through which the auxiliary-reservoir air enters the valve-chamber C, is larger than the graduating-port k', and therefore the pressure in the valve-chamber is kept substantially equal to that in the auxiliary reservoir. This retention of the pressure in the valve-chamber when graduating holds the main valve 22 and the check-valve 26 seated on their respective ports. As the main valve 22 remains immovable on its port at the time the brakes are being applied by the graduation-valve, it serves to arrest the movement of the piston by means of the stop-shoulder q on the stem coming in contact with it. The piston 29 and its attached parts will remain in the same position—to wit, with the stem-shoulder q in contact with the main valve 22—until the pressure has been reduced in the auxiliary reservoir below that in the

train-pipe. The greater train-pipe pressure will then cause the piston 29 to move to the right till the end of the valve-stem 18 comes in contact with the spring-held abutting-piece 14, which retards the movement. When in this last position, the graduating-port *k'* in the valve-stem 18 is closed by having passed into the main valve 22, and thus prevents any further accumulation of pressure in the brake-cylinder. While in this position the cup-valve 17, which controls the release of the air, has not moved sufficiently far to uncover the release-port *i*, that leads to the atmosphere, and thereby holds the pressure in the brake-cylinder, which exerts the desired braking force. If it is desired to gradually increase the pressure in the brake-cylinder, the above operation may be repeated. To release the brake, the engineer's valve is moved, and thereby the maximum pressure is restored in the train-pipe, which, acting on the piston 29, overcomes the resistance of the abutting spring 16 and moves the piston and its attached parts to the right to the extreme limit of its movement, as shown in Fig. 3, which causes the release-valve 17 to uncover the release-port *i* and allow the air to pass from the brake-cylinder back through the passage *g*, then into the central passage *h*, around the stem 18, through the port *i*, and from thence to the annular passage *h'* in the bushing 11, from which it passes through the passage G to the atmosphere. At the same time that the brakes are released the restoration of the pressure in the train-pipe will recharge the auxiliary reservoir for future use. The brakes may be applied fully in two ways: first, by the auxiliary-reservoir pressure alone, and, second, by the auxiliary-reservoir pressure in conjunction with the train-pipe pressure. The first mode is used when an ordinary gradual stop is required, such as at a station. The second mode is used when an emergency stop is required, such as upon the occurrence of an accident. To apply the brakes fully for an ordinary stop, a limited amount of train-pipe air is continuously discharged from the engineer's valve, which reduces the pressure in the train-pipe and slowly moves the piston 29 to the left and opens the main valve 22 sufficient to practically maintain the same air-pressure on both sides of the said piston. The piston and the said valve will be retained in the position just mentioned, or the piston will slightly vibrate back and forward, causing the valve 22 to repeatedly unseat and seat by the discharge of the auxiliary-reservoir air (through the valve-chamber C to the brake-cylinder) being about equal to the continuous discharge of air from the train-pipe at the engineer's valve. Under these conditions the pressure in the brake-cylinder, valve-chamber C, and auxiliary reservoir will equalize, and thus the ordinary function of the triple valve in applying the brakes fully by the auxiliary-reservoir pressure alone is accomplished. If the train-pipe pressure continues to lower slowly, the piston and its attached parts will be moved their full stroke to the left; but the air from the train-pipe will not pass to the brake-cylinder, because by this continuous but limited discharge of train-pipe pressure the air-pressure in the valve-chamber C will not be suddenly reduced below that in the train-pipe, as in this operation the main valve will not be opened sufficiently to discharge

more air than the passage B supplies. To apply the brakes of a train quickly and with full power for an emergency stop, the engineer's valve will be moved to close communication between the storage-tank on the locomotive and train-pipe and open the latter to the atmosphere and effect a sudden reduction of pressure of from ten to twenty pounds in the train-pipe. The effect of this sudden diminution of pressure in the train-pipe is immediately manifested at the triple-valve mechanism on the first car, causing the valve piston 29 to be moved by the higher pressure of auxiliary-
1318 reservoir air quickly to its full outward position, thus moving the main valve 22 and opening the main port *c*, so that the air-pressure contained in the valve-chamber C may exhaust freely into the brake-cylinder. The supply of air from auxiliary reservoir to the valve-chamber is conducted through the restricted or small passage B. Hence when the main port *c* is fully opened and the air in valve-chamber C escapes through the larger passage thus provided, the pressure in said valve-chamber is quickly reduced below that in the piston-chamber D on the auxiliary-reservoir side, notwithstanding the fact that both the valve-chamber and the piston-chamber on said side receive air from the same source—*i. e.*, the auxiliary reservoir. The exhaustion of pressure from the valve-chamber C or the great reduction of pressure therein following the sudden opening of the main port *c* brings said air pressure below that existing in the train-pipe, whereupon the check-valve 26 will be immediately unseated by said train-pipe pressure, and train-pipe air will then pass directly into the brake-cylinder J, thus effecting the quick application of the brakes and also further reduction of pressure in the train-pipe that will be sufficient to accelerate the action of the valve mechanism on the cars following. The piston 29 will in the meantime be held to its outward position by the relatively higher air-pressure from the auxiliary reservoir, which is delivered through the large passage A, while the transmission of auxiliary-reservoir air to the brake-cylinder is retarded by having to pass through the relatively smaller passage B. Thus a considerable volume of train-pipe air at lower pressure—say fifty to sixty pounds—will flow into the brake-cylinder, notwithstanding the admission of the auxiliary-reservoir air under a higher pressure, because the flow of auxiliary-reservoir air is so retarded by the smaller passage B that an appreciable period of time is required to raise the pressure in the brake-cylinder so that it and that in the auxiliary reservoir will be equal, and it is during this interval and before the pressure in the brake-cylinder is raised to equal that in the train-pipe that the air from the latter is free to enter the brake-cylinder. It will thus be seen that the sudden uncovering of the main port *c*, leading to the brake-cylinder, opens communication both between the train-pipe and brake-cylinder and also between the auxiliary reservoir and the brake-cylinder. As soon as the pressure above the check-valve, caused by the auxiliary-reservoir air plus the pressure of the spring 27, exceeds the pressure exerted by the train-pipe air on the other side the check-valve will close and the further ingress of train-pipe air to the brake-cylinder will

be cut off, while the auxiliary-reservoir air will continue to flow, thus augmenting the pressure in the brake-cylinder. This valve mechanism belongs to the class of air-brake valves known as "triple valves," of which there are numerous examples, differing somewhat in construction and embodying variations and modifications in the form and arrangement of parts; but all of them, however specially constructed, contemplate a valve structure having suitable connections for the train-pipe, the auxiliary reservoir, and the brake-cylinder, and they are provided with passages or ports leading, first, from the train-pipe to the auxiliary reservoir; second, from the said reservoir to the brake-cylinder, and, third, from the brake-cylinder to the atmosphere. Hence the name "triple valves."

An examination of the particular embodiment of the present invention will disclose the fact that it is a triple valve *per se* without auxiliary or supplemental valve devices, and, further, that its conversion into a "quick-action" valve and its greater capacity for action over previous forms of triple valves is due to means here employed for transmitting train-pipe air direct to the brake-cylinder through the triple-valve chamber C and through the port *c* of the triple main valve, and at the same time retarding or restricting the flow of auxiliary-reservoir air to the said main port as compared with the more open or free delivery of train-pipe air to said main port. It will also be seen that a single valve 22, the main valve of the triple valve proper, here performs the office of opening a port *c* to the brake-cylinder, through which port both the train-pipe and the auxiliary-reservoir airs pass in the quick application of the brakes for emergency stops.

In my application for letters patent filed September 30, 1889, serial No. 325,474, I have shown and described a valve for automatic air-brakes of the same type as that which constitutes the subject-matter of the present specification. In my said earlier application the fundamental features of the invention have been claimed. The present specification therefore relates to certain improvements in the construction of said valves.

Having thus described my invention, what I claim as new, and desire to secure by letters patent, is—

1. A triple valve for automatic air-brakes, having, in combination, a port *c*, leading to the brake-cylinder, a main valve 22, which closes and opens said port, a valve to release the air from the brake-cylinder, a piston actuated by air-pressure, and a stem having one end suitably connected with the piston and which passes loosely through the main valve and also through the said port leading to the brake-cylinder and imparts movement to the said release-valve.

2. A triple valve for automatic air-brakes, having, in combination, a port *c*, leading to the brake-cylinder, a main valve 22, which closes and opens said port, a valve to release the air from the brake-cylinder, a piston actuated by air-pressure, a stem having one end suitably connected with the piston and which passes loosely through the main valve and also through the said port leading to
1319 & 1320 the brake-cylinder and imparts movement to the said release-valve, and a stop-shoulder on the said stem between the main valve and release-valve.

3. A triple valve for automatic air-brakes, having, in combinatio a port *c*, leading to the brake-cylinder, a piston actuated by ai pressure, a stem having one end suitably connected with the pisto constructed to act as a graduating-valve, a main valve 22, loose o said stem and which rides or floats lengthwise thereof and is wholl supported thereby and opens and closes the said port leading to th brake-cylinder, and a stop-shoulder on the stem to come in contac with the said main valve, whereby when the brakes are being ap plied by the graduating-valve the main valve remains immovabl and the stop-shoulder coming in contact with it arrests the movemen of the said piston.

4. A triple valve for automatic air-brakes, having, in combinatio a passage from the train-pipe, a passage from the auxiliary reservoi which is smaller or more restricted than said train-pipe passage, main port co-acting with both of said passages and communicatin between them and the brake-cylinder, a piston actuated by ai pressure, a stem having one end suitably connected with the pistor and a valve loose on said stem and which rides or floats lengthwis thereof and is wholly supported thereby and opens and closes th said main port communicating to the brake cylinder.

5. A triple valve for automatic air-brakes, having, in combination a valve to release the air from the brake-cylinder, a piston actuate by air-pressure, a main port *c*, leading to the brake cylinder an located between the said release-valve and piston, a stem having on end suitably connected with the piston and which passes throug said port and imparts movement to the said release-valve, and sai stem provided with a passage having a lateral port for the flow o a small volume of air to apply the brakes by graduation, and main valve 22, which is free to ride or float lengthwise on said sten and opens and closes the said lateral graduation-port and which als opens and closes the main port leading to the brake-cylinder.

6. A triple valve for automatic air-brakes, having, in combination a port communicating with the brake-cylinder from both the auxil iary reservoir and the train-pipe, means for restricting the flow t the said port of auxiliary-reservoir air when applying the brake for an emergency stop as compared with the flow of train-pipe air a piston actuated by air-pressure, a stem having one end suitabl connected with the piston and which is provided with a smal passage for the flow of auxiliary-reservoir air to apply the brake by graduation, and a main valve 22, which rides or floats loosel on said stem and is wholly supported thereby and opens and close the said port communicating with the brake-cylinder and als controls the said small graduation-passage.

In testimony whereof I affix my signature in the presence of tw witnesses.

GEORGE A. BOYDEN.

Witnesses:
JNO. T. MADDOX.
F. P. DAVIS.

1331 UNITED STATES PATENT OFFICE.

GEORGE A. BOYDEN, of Baltimore, Maryland, assignor to the Boyden Brake Company of Baltimore City, of Maryland.

Valve for Automatic Air-brakes.

Specification forming part of Letters Patent No. 481,136, dated August 16, 1892. Application filed February 12, 1892. Serial No. 421,237. (No model.)

To all whom it may concern:

Be it known that I, George A. Boyden, a citizen of the United States, residing at Baltimore, in the State of Maryland, have invented certain new and useful improvements in valves for automatic air-brakes, of which the following is a specification.

This invention relates to a new and improved valve for automatic air-brakes of that class which are called "triple valves." One object of the invention is to provide for admitting air-pressure to the brake-cylinder from both the train-pipe and the auxiliary reservoir by the ordinary slide-valve of the triple valve to produce a quick application of the brakes, and thereby avoid employing an auxiliary valve.

Another object is to provide triple valves which employ slide-valves with new and improved means for graduating without the complication of additional movable parts to the slide-valve and piston, which said means shall be controlled by slight variations of pressure in the train-pipe, so that any desired degree of brake-pressure may be applied to the wheels of the cars.

Since the air-brake triple valve proper has been developed to the slide-valve form, as shown in United States patent to Westinghouse, No. 168,359, dated October 6, 1875, two additional or "auxiliary" valves have been arranged to co-operate with the said triple valve to perform additional functions in braking—to wit, that of "graduating" the brakes—a function that is illustrated in United States patent to Westinghouse, No. 220,556, dated October 14, 1879, and that of "quick action," which is to apply the brakes with greater rapidity and power by partially exhausting the train-pipe of air and discharging said air, together with auxiliary-reservoir air, into the brake-cylinders, a function that is illustrated in United States patent to Westinghouse, No. 360,070, dated March 29, 1887.

Heretofore in triple valves which employ slide-valves where the endeavor has been made to provide for quick action in emergency stop the auxiliary-reservoir air alone has passed to the brake-cylinder by the opening of the slide-valve, while the train-pipe air has passed to said cylinder by a different valve—that is, the auxiliary valve last referred to.

The first part of my present invention consists, broadly, in the combination, with a triple valve having a piston and slide-valve which is moved one way by auxiliary-reservoir-air pressure, of

BLEED THROUGH POOR COPY

means whereby both train-pipe air and auxiliary-reservoir air may be admitted by the same slide-valve to the brake-cylinder for applying the brakes. By this part of my invention the air from the train-pipe may be admitted directly to the brake-cylinder without interfering with the usual operation or functions of the triple valve, and also without the aid of the auxiliary valve heretofore required for the purpose. My invention enables the triple valve alone to produce what is called "quick action" in emergency applications.

The second part of my invention consists in the combination, with a slide-valve which is operated by the movement of a piston, of a passage for auxiliary-reservoir air to preliminarily apply the brakes gradually or partially with any degree of pressure, the inlet to which passage is controlled by the said piston and the exit from the passage is controlled by the slide-valve. By this part of my invention the "graduation" or partial application of the brakes may be effected without the use of an auxiliary valve, and also without liability when closing the graduating-passage which admits auxiliary-reservoir air to the brake-cylinder to move the slide-valve to the "release position," where the brake-cylinder air will exhaust to the atmosphere, and thus unintentionally release the brakes at a time when it is desired to keep them applied.

The invention is illustrated in the accompanying drawings.

(Here follow diagrams marked pp. 1322, 1324, 1326, 1328 & 1330.)

Figure 1 shows an auxiliary reservoir and brake-cylinder in section and a side view of my improved valve and illustrates one way of attaching the said valve. Fig. 2 is a longitudinal section of the improved valve on the line 2 2, showing all the parts, the slide-valve being in the release position. Fig. 3 is a view of the valve-case at that end which is to be secured to the auxiliary reservoir. Fig. 4 is a longitudinal section of the valve-case on the line
1332 4 4, which is transverse to that on which Fig. 2 is taken and shows the slide-valve seat. Fig. 5 is a cross-section of the valve-case on the line 5 5. Figs. 6, 7, and 8 are views of the slide-valve. Fig. 9 is a view of the piston, the parts which are rigidly connected with it, and the slide-valve, these composing all the parts which are removable from the body of the case for inspection or cleaning. Fig. 10 is an end view of the partition, slide-valve, and piston. Fig. 11 is a section of the complete valve, showing the piston, slide-valve, and check-valve in the emergency-stop position and while the train-pipe air is flowing to the brake-cylinder. Fig. 12 shows a modification in the structural features of the valve-case and in the organization of the parts, but which employs a slide-valve, as in Fig. 2, and has the same mode of operation as the structure there shown. Fig. 13 shows a cross-section of the valve-chamber seen in Fig. 12 on the line 13 13.

The valve-case 5 is to be connected with the auxiliary reservoir or brake-cylinder, as desired, and secured at any suitable place, so that the passages A to the piston-chamber will communicate with

8048

(No Model.)

5 Sheets—Sheet 1.

G. A. BOYDEN.

VALVE FOR AUTOMATIC AIR BRAKES.

No. 481,136. Patented Aug. 16, 1892.

Nos 403 & 426.
Westinghouse Co
v
Boyden Co
p1382

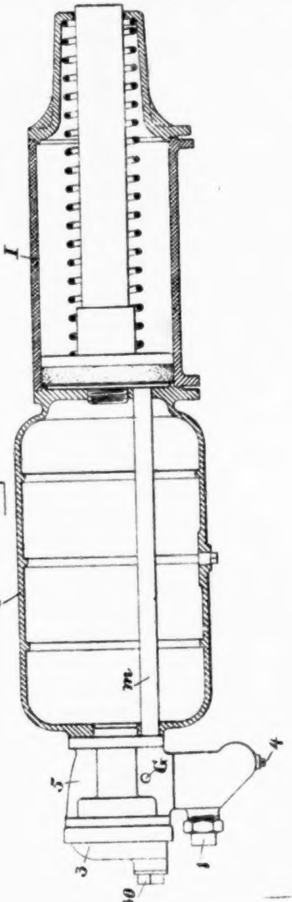


Fig.1.

WITNESSES:
J. P. Davis.
A. O. Babendreier

INVENTOR
Geo A. Boyden
By Chas B. Mann
Atty.

8044

Nos. 403 & 426
Westinghouse Co. v. Boyden Co } p 1324

(No Model.) 5 Sheets—Sheet 2.

G. A. BOYDEN.

VALVE FOR AUTOMATIC AIR BRAKES.

No. 481,136. Patented Aug. 16, 1892.

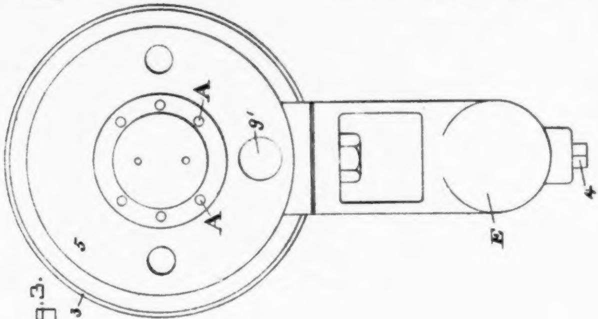
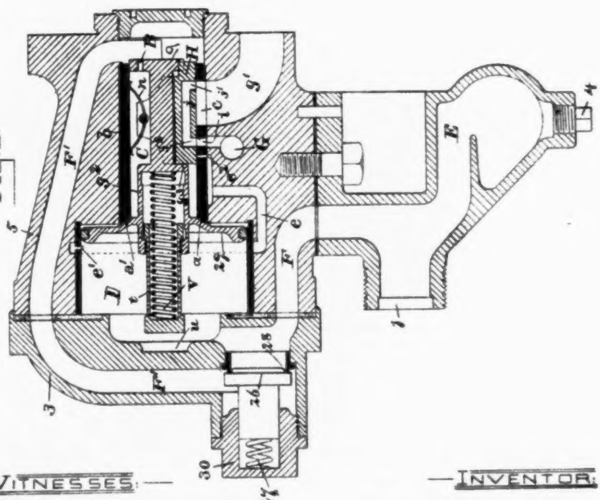


Fig. 3.

Fig. 2.



WITNESSES:

T. P. Davis.
A. O. Babendreier.

INVENTOR:

Geo A. Boyden
By Chas B. Mann
Atty.

BLEED THROUGH POOR COPY

No 483 0426
Westinghouse } p 1326
& Boyden Co

(No Model.)

5 Sheets—Sheet 3.

G. A. BOYDEN.

VALVE FOR AUTOMATIC AIR BRAKES.

No. 481,136. Patented Aug. 16, 1892.

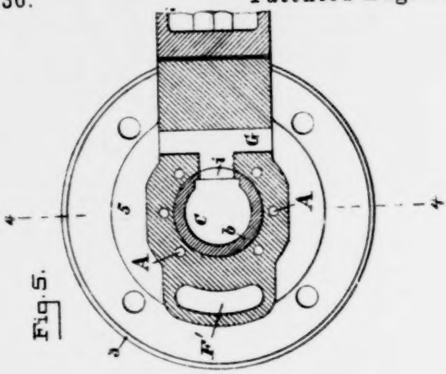


Fig. 5.

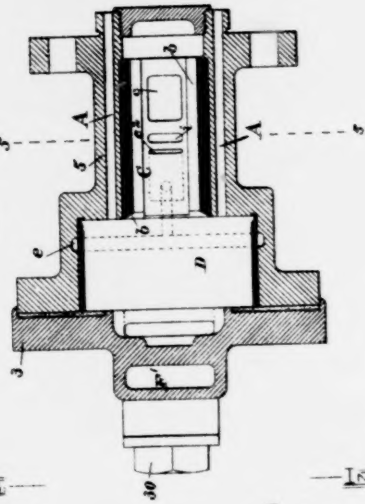


Fig. 4.

WITNESSES

J. R. Davis.
A. O. Babendreier.

INVENTOR

Geo A. Boyden
By Chas B. Mann
Atty.

8046

Nos. 403, 426. Westinghouse Co } p137-8
Boyden Co.

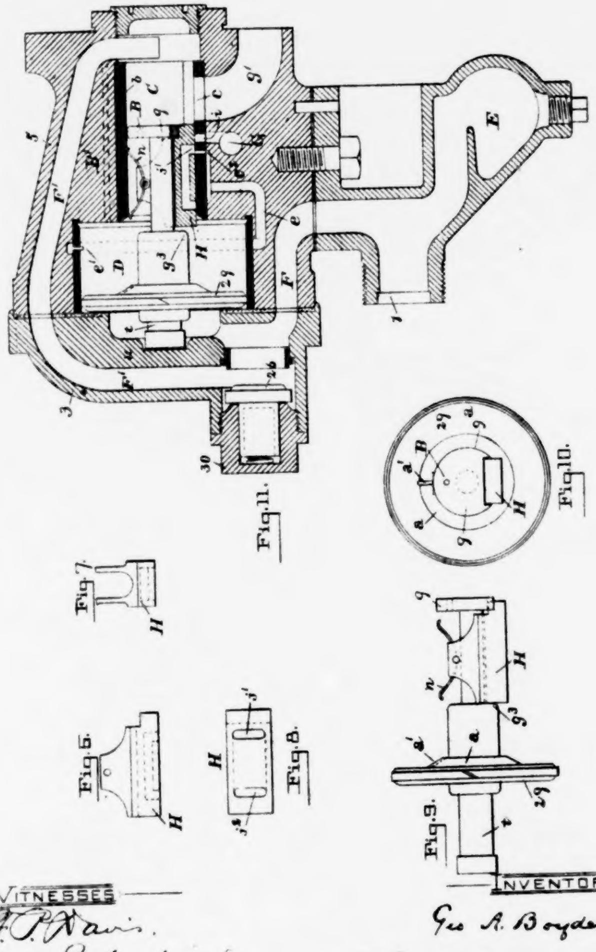
(No Model.)

5 Sheets—Sheet 4.

G. A. BOYDEN.

VALVE FOR AUTOMATIC AIR BRAKES.

No. 481,136. Patented Aug. 16, 1892.



WITNESSES:
J. P. Davis.
A. O. Babendreier

INVENTOR:
Geo A. Boyden
By Chas B. Mann
Atty.

BLEED THROUGH POOR COPY

8047

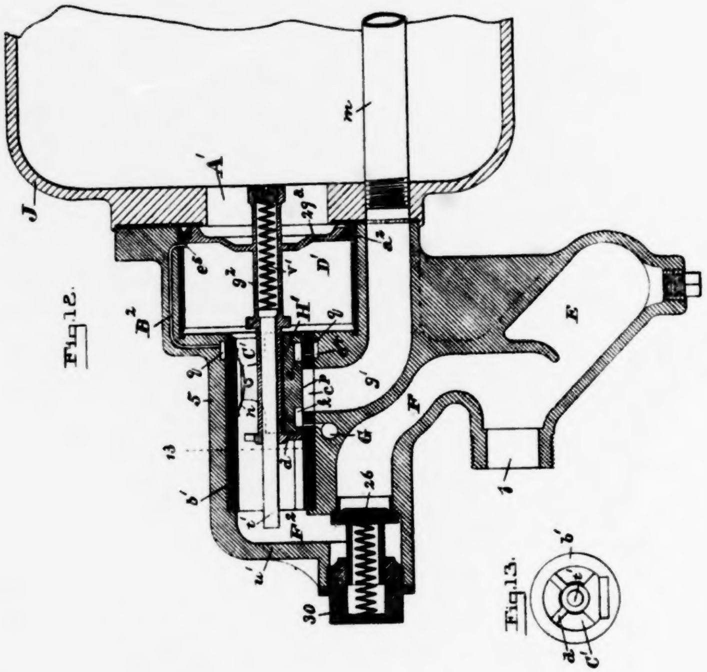
Nos. 403 & 426
Westinghouse Co. } p. 1330.
Boyden Co.

(No Model.) 5 Sheets—Sheet 5.

G. A. BOYDEN.

VALVE FOR AUTOMATIC AIR BRAKES.

No. 481,136. Patented Aug. 16, 1892.



WITNESSES:
J. P. Davis.
A. O. Babendreier.

INVENTOR:
Geo A. Boyden
By Chas B. Mann
Atty.

BLEED. THROUGH POOR COPY

said reservoir and the passage g' from the valve-chamber will communicate with the brake-cylinder. The nozzle 1 is to be connected with the train-pipe, the exhaust-passage G opens to the atmosphere, and the port i in the valve-chamber is the inner end of this exhaust-passage. The valve-case is provided with an ordinary drip-chamber E to receive the water of condensation, and the water may be drawn therefrom by removing a plug 4. The piston-chamber D, valve-chamber C, piston 29 and attached stem g^2, the slide-valve H, and spring n, which holds the said valve to its seat, are all relatively arranged substantially like those parts in triple valves heretofore made.

The first part of my invention will now be described.

Referring to the drawings Figs. 2 to 9, one side of the piston 29 is provided with a conical projection or face a, which stops against the end of the bushing b of the valve-chamber C. Extending from this side of the piston is the stem g^2, which projects into the valve-chamber and moves the slide-valve H. A passage F leads from the train-pipe nozzle to the piston 29, and a continuation F′ of this passage leads around the piston-chamber D to the far or right-hand end of the said bushing b. A check-valve 26 is located at some suitable point in this passage and a spring 27 holds it normally to its seat 28. A cap-nut 30 serves as a guide for the stem of the check-valve and also confines it. By removing the cap-nut the check-valve may be withdrawn. The piston-stem g^2 carries a head or partition 9, which fits snugly and moves in the valve-chamber bushing b. In Figs. 2, 8, 9, and 10 this partition is shown located on the end of the stem and acts on the end of the slide-valve when the piston moves outward or to the left. When the piston has completed its full stroke to the left—the emergency-stop position, (see Fig. 10,)—the brake-cylinder port c is wide open and the partition 9 serves to retard or restrict the auxiliary-reservoir air in its transmission to the said port. At the moment the brakes are being applied for an emergency stop the partition has the effect to confine on the auxiliary-reservoir side of the piston a greater pressure than that of the air passing through the brake-cylinder port, as hereinafter explained. A restricted or small passage B through the partition 9 serves as an air communication between opposite sides thereof. A feeding-groove a' is formed on the conical face of the piston 29. Passages A are formed in the case around the valve-chamber and constitute a direct communication between the auxiliary reservoir and the piston-chamber D and without passing through the valve-chamber C. In the present instance six passages A are shown, the combined area or capacity of which affords an ample supply of auxiliary-reservoir air for emergency applications. If desired, the number of these passages may be varied. One passage will serve the purpose as well if it is large enough. The cap 3 is secured to the valve-body 5 by suitable bolts. By taking off this cap all the movable parts of the valve, including those which produce quick action, may be withdrawn for inspection or repair. The communication between the train-pipe nozzle 1 and the auxiliary reservoir for charging the same with compressed air is

BLEED. THROUGH POOR COPY

by way of the passages F F′, restricted passage B, valve-chamber C groove a', piston-chamber D, and the passages A. Communicatio between the train-pipe nozzle 1 and the brake-cylinder direct t produce quick action in emergency stops is by way of the passage F F′, slide-valve port c, and passage g'. Communication betwee the auxiliary reservoir and brake-cylinder for ordinary full appl cation of the brakes, also for quick action, (not including graduatin however,) is by way of the passages A, piston-chamber D, valv chamber C, restricted passage B, slide-valve port c, and passage g Communication between the brake-cylinder and atmosphere t release the brakes is by way of the passage g', slide-valve port c, th cavity j in the slide-valve, the port i in the seat of the slide-valv and the exhaust-passage G.

It will be seen by the foregoing that a novel feature of this pa of my invention is that one and the same slide-valve H here serv three purposes, to wit: First, quick action in applying the brak for emergency stops by the passage of train-pipe air to the brak cylinder in conjunction with auxiliary-reservoir air; secon ordinary full application of the brakes by the passage of auxiliar reservoir air alone to the brake-cylinder, and, third, the release the brakes.

The second part of the invention—to wit, the improved means f gradually applying the brakes—will now be described.

1333 A passage e to admit auxiliary-reservoir air to produce graduated application of the brakes is in the valve-case an leads from the piston-chamber D to the seat of the slide-valv where its exit-port e^2 opens through the bushing b to said seat. T slide-valve H is provided with a cavity j, and its face has two ope ings in the form of cross-slots j' j^2, one opening being at each en of said cavity, which serve to complete the communicati between the exit-port of said graduating-passage and the slide-val port c, leading to the brake-cylinder. The piston 29 opens an closes the inlet-port e' of the graduating-passage, so that auxiliar reservoir air may enter the said passage and flow to the brak cylinder as soon as the opening j^2 of the slide-valve cavity registe with the exit-port e^2, and thereby establishes communication b tween the said passage e and the main port c. The passage fro the auxiliary reservoir to the brake-cylinder for graduating is follows: by way of the passage A, piston-chamber D, passage cavity j in the slide-valve, and passage g.′ The piston 29 is provid on the train-pipe side with a yielding stem or knob t, which com in contact with a plate u to check or retard the movement of t piston when graduating. The knob-stem t fits telescopically throu the piston and into its stem g^2, and a spiral spring v serves to ke the knob-stem projected with a certain degree of tension.

The operation of my improved valve is as follows: To charge t auxiliary reservoir, the air from the train-pipe entering at the noz 1 passes through the passage F to the piston 29 and moves it to t position shown in Fig. 2, where the release-port is open. The a continuing, opens the check-valve 26 to the passage F′ and pass to the partition 9, then through the small passage B to the valv

chamber C, through groove a' to the piston-chamber D, and then through the passages A to the auxiliary reservoir. The brakes may be applied fully in two ways: first, by the auxiliary-reservoir pressure alone, and, second, by the auxiliary-reservoir pressure in conjunction with the train-pipe pressure. The first mode may be used when an ordinary gradual stop is required, such as at a station. The second mode produces quick action and is used when an emergency stop is required, such as upon the occurrence of an accident. To apply the brakes fully by auxiliary-reservoir-air pressure alone, the engineer's valve is turned to gradually and continuously discharge air from the train-pipe. This particular manner of discharging air at the engineer's valve will slowly move the piston 29 and slide-valve H until they reach their full stroke to the left and open port c; but in making this slow movement the air from the train-pipe will not pass to the brake-cylinder, because there will be time sufficient for auxiliary-reservoir air to pass the restricted passage B and accumulate in the passage g' and in the brake-cylinder and by accumulating there prevent the pressure in the valve-chamber on the right-hand side of the partition and in the passage F′ from becoming reduced to such degree as will allow the diminishing train-pipe pressure to unseat the check-valve 26, and thereby prevent the passage of the train-pipe air to the brake-cylinder. Thus it will be seen that a gradual and continuous reduction of train-pipe pressure at the engineer's valve, as stated, will afford time for the air-pressure, which has been disturbed or slightly unbalanced in the several chambers and passages of the valve-case, to become readjusted and equalized and thereby prevent such a diminution of pressure on the valve-chamber side of the check-valve 26 as will cause the latter to unseat. In this way the parts of the valve device which are comprised in what I have termed the "first part" of this invention accomplish one of the ordinary functions of triple valves in applying the brakes fully by auxiliary-reservoir-air pressure alone. To apply the brakes fully by quick action for an emergency stop, the train-pipe pressure is suddenly reduced by discharging at the engineer's valve, say, about twenty pounds, which quickly moves the piston 29 and its attached parts their full stroke to the left. This will move the slide-valve H and open the port c and close the release-port i. By thus suddenly and fully opening the main port c a passage is opened from the train-pipe direct to the brake-cylinder, through which air from the train-pipe will pass. This passage is as follows: From the nozzle 1 through the passage F, the check-valve 26, and passage F′, and as the slide-valve H has been quickly moved to its full open position the condition of pressure will be favorable, as hereinafter explained, and the air will pass through this valve-port c directly from the train-pipe to the brake-cylinder. This operation of the valve is due to the coaction of three momentary differential pressures immediately after the piston 29 has suddenly moved its full stroke to the left. These pressures approximately are seventy pounds from the auxiliary reservoir acting on the piston 29 and holding it to the extreme end of its stroke; fifty pounds in the train-pipe and at op-

BLEED. THROUGH POOR COPY

posite side of piston, due to the twenty pounds reduction by the aforesaid discharge at the engineer's valve, and, say, five pounds in the valve-chamber (see Fig. 11) on the right-hand side of the partition in the passage F′ and on one side of the check-valve 26, due to the sudden air-discharge therefrom through the wide-open port *c* and to the fact that the auxiliary-reservoir-air supply thereto is restricted through the small passage B. In this operation the fifty pounds pressure on the train-pipe side of the check-valve unseats the latter and passes through the passage F′, the open port *c*, and passage *g′* into the brake-cylinder, thereby performing two
1334 functions in quick action—to wit, partially emptying the train-pipe, which quickens the action of the triple valve on the brakes of the following car, and partially charging the brake-cylinder with the train-pipe air, which augments the pressure applied to the wheels of the car. After the air-pressures in the train-pipe and brake-cylinder have equalized auxiliary-reservoir air will continue to pass through the said open port *c* to the brake-cylinder, coming by way of the passages A, piston-chamber D, valve-chamber C, and restricted passage B, until there is an equalization of air-pressure in both said reservoir and cylinder. It will thus be seen that the piston which actuates the slide-valve is moved in one direction by auxiliary-reservoir pressure and that air may be passed through the said slide-valve port *c* to the brake-cylinder from both the train-pipe and the auxiliary reservoir to produce quick action for an emergency application of the brakes, and thereby I avoid the employment of an auxiliary valve. The quick-action function does not follow when the port *c* leading to the brake-cylinder is opened slowly and gradually, because then the pressure adjoining the partition 9 on the right-hand side is not reduced materially below the train-pipe pressure. On the other hand, the quick action will follow when said port *c* is opened suddenly and fully, because then the pressure at said location will be reduced sufficiently below the train-pipe pressure for the latter to unseat the check-valve and pass through the right-hand end of the triple-valve chamber to the brake-cylinder. The sudden movement of the slide-valve uncovers the main port *c*, leading to the brake-cylinder; but the flow of the higher-pressure air from the auxiliary reservoir into the brake-cylinder is retarded by being compelled to traverse a relatively small passage (in the present instance at the partition) while the flow of the lower-pressure train-pipe air into the brake-cylinder is facilitated by permitting it to traverse a much larger passage. Therefore the same valve-port *c* allows a considerable volume of train-pipe air to flow into the brake-cylinder, notwithstanding the admission through the same port at the same time of the auxiliary-reservoir air under a higher pressure. To release the brakes, a sufficient amount of air is admitted from the main reservoir, which is on the locomotive, to the train-pipe to overcome the resistance of the auxiliary-reservoir pressure and the friction of the slide-valve H and move the piston 29 and said valve toward the right hand to the position shown in Fig. 2, and thereby establish communication between the brake-cylinder and atmosphere by way of the passage

g', cavity j, release-port i, and exhaust G. In addition to the said quick-action result obtained by the construction and combination of parts comprising the first part of my invention another useful result or advantage is gained, to wit: Should the piston and slide-valve "stick" by reason of the accumulation of dirt or of gum formed by the oil and fail to move forward when compressed air is first applied to the brake-pipe before the train starts out, then under such circumstances the brakes would be applied by the train-pipe air passing directly to the brake-cylinder, and thereby indicate to the trainmen the defective condition of the brakes. To partially apply the brakes by graduation, either to check the speed of the train or to gradually stop, the train-pipe pressure is reduced slightly but sufficiently to move the piston and slide-valve H to a position that will put the second opening j^2 of the cavity of the valve in connection with the exit-port e^2 of the graduating-passage and cause the piston to open the inlet-port e' of said passage to the auxiliary-reservoir air. The train-pipe pressure must not be reduced enough to enable the greater auxiliary reservoir pressure acting on the piston to overcome the tension of the spring v. This movement of the piston and slide-valve to the left allows auxiliary-reservoir air to continue passing through the graduating-passage e to the brake-cylinder until the pressure on the auxiliary-reservoir side of the piston has been reduced below that which is on its train-pipe side, whereupon the train-pipe pressure will move the piston 29 (but not the slide-valve) partly back to the right until the piston-ring packing closes the inlet-port e', which by cutting off the flow of auxiliary-reservoir air will so retard the back movement of the piston that the shoulder g^3 of the stem will abut the slide-valve easily. There is sufficient play between the shoulder g^3 and the partition 9 to permit a movement of the piston independent of any movement of the slide-valve H. When the piston-shoulder g^3 abuts easily, as stated, against the end of the slide-valve, the resistance of the latter will stop the piston with its packing-ring over the said inlet-port e' for the time being and prevent any more air passing through the graduating passage e. An advantage resulting from this graduating operation is that when enough air has been entered into the brake-cylinder to effect the desired partial application of the brakes the flow of air through the graduating-passage e is cut off by the piston packing-ring, which prevents the slide-valve being abutted as severely as in devices heretofore employed. Consequently in thus first cutting off the said air-flow there is no liability to move the slide-valve to the release position and unintentionally release the brakes. Thus the graduation is effected by the slide-valve and without the use of an auxiliary valve. The restricted passage B for the supply of auxiliary-reservoir air when applying the brakes for emergency stops is shown in Figs. 2 and 10, for the purpose of clear illustration, as a small hole through the partition 9; but a special hole or passage is not necessary, as the partition 9 may fit the bushing b loosely enough to leave a small space between the rim 9^a of the partition and the wall of the bushing. Such
1335 looseness of fit or the space formed thereby may constitute

the restricted passage, and I have used valves constructed in this manner. The restricted passage may also be formed as a distinct channel in the case, as at B′ in Fig. 11 or as at B^2 in 12. The partition may be located differently from what is shown in Figs. 2 and 11. It is obvious it may be anywhere on the stem g^2, so that it is not withdrawn from the bushing when the piston completes its stroke to the left. It may also be stated that the piston itself may under certain conditions be made to serve as a partition. This is illustrated in Fig. 12.

Fig. 12 illustrates a modification in the construction and arrangement of the parts of a valve embodying my invention. This form of valve, although differently organized from that shown in Figs. 2 to 11, inclusive, has the same parts or their equivalents and has the same mode of operation and produces the same result. The valve shown in Fig. 12 differs from that shown in the other figures chiefly in that the slide-valve of Fig. 12 is located on the train-pipe side of the actuating piston, whereas in the other figures it is located on the auxiliary-reservoir side of said piston. Referring to Fig. 12, the valve case 5 is connected with the auxiliary reservoir J and a communication A′ opens at one end of said reservoir direct to one side of the piston 29^a and without passing through the valve-chamber C′. The passage g' leads from the valve-chamber to the brake-cylinder I through a pipe *m*. The nozzle 1 connects with the train-pipe, the exhaust-passage G opens to the atmosphere, and the port *i* through the valve-seat connects with said exhaust-passage. The piston 29^a, stem g^2, head *d*, slide-valve H′, and spring *n* are all substantially like the same parts in Fig. 2. The check-valve 26 is located in the train-pipe passage F, as in the other figures. The relative positions of the piston and slide-valve in the valve-case are reversed in Fig. 12 from what they are in Fig. 2, and a feed-groove a^2 is in the bushing of the piston-chamber D′. The piston 29^a in this modification serves the same functions as the piston 29 in Fig. 2; but it here serves also a function ascribed to the partition 9 in Fig. 2, namely: At the moment when the brakes are being applied for an emergency stop the piston has the effect to confine on its auxiliary-reservoir side a greater pressure than that of the air passing through the brake-cylinder port *e*. This last function results from the location of the piston on the auxiliary-reservoir side of the slide-valve and the combination therewith of an ample or large passage F F^2 for train-pipe air and a restricted or small passage B^2 for the supply of auxiliary-reservoir air when applying the brakes for emergency stops. This restricted passage B^2 has its inlet e^5 in the piston-chamber and its exit in an annular groove *q* around the valve-chamber. In this instance the passage from the train-pipe nozzle for charging the auxiliary reservoir and to the brake-cylinder to produce quick action in emergency stops is through the valve-chamber C′ and past the back of the slide-valve H′. The piston-stem g^2 is tubular and on the train-pipe side has a yielding stem *t′*, which fits and moves telescopically into the piston-stem, and a spiral spring *v′* keeps the yielding stem normally projected. The end of the yielding stem *t′* comes in contact with a plate *u′* and retards the move-

nent of the piston when graduating. The slide-valve I I′ in this case has two cavities k o and a central face p between them. One cavity k connects the brake-cylinder passage g' with the release-port i and the other cavity o connects with a port e^4 in the slide-valve seat, which port communicates with the restricted passage B^2 by way of the annular groove q in the case, which groove is covered by the bushing b'. To charge the auxiliary reservoir, Fig. 13, train-pipe air passes through passage F F^2, valve-chamber C, piston-chamber D′, and feed-groove a^2. To apply the brakes fully by auxiliary-reservoir pressure alone, the piston 29^a moves slowly to the left and then air passes from the auxiliary reservoir J through the port e^5, restricted passage B^2, annular groove q, port e^4, in the slide-valve seat, and passage g' to the brake-cylinder. This will continue until the full power of the auxiliary-reservoir air is exerted in the brake-cylinder. To apply the brakes fully by quick action for an emergency stop, the piston 29^a must be moved quickly to the left, and thus suddenly open the main port e. The air pressure in the valve-chamber C′ between the piston and the check-valve will at once discharge through the passage g' into the brake-cylinder, which will reduce the pressure at said location below the train-pipe pressure. Thereupon the check-valve 26 will unseat and train-pipe air will pass freely to the brake-cylinder by way of the passage F F^2 back of the slide-valve II′ through the port e and passage g'. At the same time the auxiliary-reservoir air at higher pressure than the said train-pipe air will also pass to the brake-cylinder through the restricted or small passage B^2, annular groove q, port e^4, port e, and passage g'. Thus in applying for emergency air passes to the brake-cylinder through the same port from both the train-pipe and the auxiliary reservoir. To release the brakes, the piston 29^a is moved toward the right hand to the position shown in Fig. 12, where the cavity k in the slide-valve connects the passage g' with the releas-port i, and thus establishes communication from the brake-cylinder to the atmosphere. To partially apply the brakes by graduation, the piston 29^a will be moved from the position shown in Fig. 12 toward the left far enough to open the inlet-port e^5 to the auxiliary-reservoir air, and also put the cavity o of the slide-valve in connection with the port e^4, and also the passage g', leading to the brake-cylinder. In graduation the piston 29^a is kept in
1336 this position but a moment, and then moves toward the right hand and covers the inlet-port e^5, and thereby stops the flow of auxiliary-reservoir air to the brake-cylinder. It will thus be seen the passage B^2 in this modification serves to transmit auxiliary-reservoir air to the brake-cylinder in a restricted manner when applying for emergency stops, and also to transmit such air when graduating.

It will be seen that no auxiliary valve is employed and that a single slide-valve controls the compressed air in the several actions which the apparatus is designed to perform—to wit, applying the brakes by the full power of auxiliary-reservoir pressure alone, releasing the brakes, applying the brakes on the so-called "quick-action" plan—*i. e.*, by train-pipe pressure in conjunction with auxiliary-reser-

voir pressure—and partially or wholly applying the brakes by graduating. It will also be seen that while I have provided for the said quick-action result to be effected by a single slide-valve alone and without an auxiliary valve, yet this feature of my invention may be worked or employed in connection with graduating devices of different structure from that here shown.

It is to be understood that various of the structural features here shown or described and the form and location of the ports and passages may be changed or varied without departing from my invention.

Having thus described my invention, what I claim as new, and desire to secure by letters patent, is—

1. The combination, in valve mechanism for automatic air-brakes, of a port through which air passes to the brake-cylinder from both the train-pipe and auxiliary reservoir to produce quick action, a port leading to the atmosphere to exhaust the air from the brake-cylinder, a single slide-valve to control the said ports, and a piston which actuates the slide-valve and is moved in one direction by auxiliary-reservoir pressure and in the opposite direction by train-pipe pressure.

2. The combination, in valve mechanism for automatic air-brakes, of a piston actuated in one direction by auxiliary-reservoir pressure and in the opposite direction by train-pipe pressure, and a single slide-valve controlling the passage of air to the brake-cylinder from both the train-pipe and auxiliary reservoir for an emergency application of the brake.

3. The combination, in valve mechanism for automatic air-brakes, of a piston-chamber, a piston, a valve-chamber having a port through which air passes to the brake-cylinder from both the auxiliary reservoir and train-pipe, a slide-valve controlling said port, and a partition which at the time of applying the brakes separates the auxiliary-reservoir-air pressure that is on the said piston from the pressure in that part of the valve-chamber that is adjacent to the said port.

4. The combination, in valve mechanism for automatic air-brakes, of a valve-chamber, a slide-valve therein controlling the exhaust of air from the brake-cylinder to the atmosphere and also the passage of air to the brake-cylinder from both the train-pipe and the auxiliary reservoir, a piston-chamber, and a piston to actuate the said slide-valve and carrying a partition arranged to retard or restrict the auxiliary-reservoir air in its transmission to the port of the said slide-valve.

5. The combination, in valve mechanism for automatic air-brakes, of a port through which air passes from both the auxiliary reservoir and train-pipe to the brake-cylinder, a port leading to the atmosphere, a passage for auxiliary-reservoir air to pass to said brake-cylinder port, a passage having a greater area than the first-mentioned passage to admit train-pipe air to said brake-cylinder port, a slide-valve to control said ports, and a check-valve located in the said train-pipe passage.

6. The combination, in valve mechanism for automatic air-brakes,

piston-chamber, a piston, a valve-chamber having a port lead-to the atmosphere and also a port leading to the brake-cylinder, lide-valve controlling the said ports, a communication for iliary-reservoir air direct to one side of the said piston without sing through the valve-chamber, and a restricted communication auxiliary-reservoir air to pass to said brake-cylinder port.

. The combination, in valve mechanism for automatic air-brakes, valve-port through which air passes to the brake-cylinder from h the auxiliary reservoir and direct from the train-pipe, an ex-ust-port, a slide-valve to control the said port, a piston, and com-nications relatively proportioned to produce on the auxiliary-ervoir side of the piston a greater pressure than that of the said passing through the brake-cylinder port.

. The combination, in valve mechanism for automatic air-brakes, a slide-valve seat having a port which is in communication with brake-cylinder, a passage through which train-pipe pressure is nsmitted to the said brake-cylinder port when applying the brakes emergency stops, a passage of more restricted capacity than said in-pipe passage and through which auxiliary-reservoir pressure so is transmitted to the said brake-cylinder port when applying brakes for emergency stops, and a slide-valve resting on said t and coacting with said port and controlling the passage to the ake-cylinder of both the train-pipe and auxiliary-reservoir press-e, as set forth.

9. The combination, in valve mechanism for automatic air-brakes, a slide-valve, a piston which actuates the said slide-valve, and a aduating-passage for auxiliary-reservoir pressure to preliminarily ply the brakes, the exit from which passage is controlled by the id slide-valve and the inlet thereto by the said piston and which ssage admits auxiliary-reservoir pressure to the brake-cylinder when open at both of said controlled places.

337 & 1338 10. The combination, in valve mechanism for automatic air-brakes, of a slide-valve seat having a port hich is in communication with the brake-cylinder, a passage lead-ng to the said slide-valve seat and through which auxiliary-reservoir ressure is transmitted for graduating the brakes, a passage through hich train-pipe pressure is transmitted to the said brake-cylinder ort when applying the brakes for emergency stops, a passage of nore restricted capacity than said train-pipe passage and through which auxiliary-reservoir pressure also is transmitted to the said brake-cylinder port when applying the brakes for emergency stops, and a slide-valve traversing said seat and controlling the air pass-ng through all three of said passages.

11. The combination, in valve mechanism for automatic air-brakes, of a slide-valve seat having a port which is in communication with the brake-cylinder, a passage leading to the said slide-valve seat and through which auxiliary-reservoir pressure is transmitted for graduating the brakes, a passage through which train-pipe pressure is transmitted to the said brake-cylinder port when apply-ing the brakes for emergency stops, and a single slide-valve travers-

BLEED THROUGH POOR COPY

ing the said valve-seat and controlling the said passages, for the purpose set forth.

12. The combination, in valve mechanism for automatic air-brakes, of a slide valve seat having three ports, the first of which is in communication with the brake-cylinder and the second with the atmosphere, a graduating passage leading to the third valve-seat port and through which auxiliary-reservoir air is transmitted to preliminarily apply the brakes, a single slide-valve traversing the said seat and controlling the graduating or preliminary application of the brakes and the release of the same, and a piston to actuate the said slide-valve and having a limited movement independent thereof.

In testimony whereof I affix my signature in the presence of two witnesses.

GEORGE A. BOYDEN.

Witnesses:

FRANK P. DAVIS.
JNO. T. MADDOX.

1339 *Complainants' Testimony in Reply, under Order of Court Made March 29th*, 1894.

United States Circuit Court, District of Maryland.

GEORGE WESTINGHOUSE, JR., *et al.* *vs.* BOYDEN POWER BRAKE CO. *et al.*	In Equity. No. 321.

Messrs. Barton & Wilmer, solicitors for defendants, Baltimore, Md.

GENTLEMEN: Please take notice that testimony on behalf of complainants, in reply to defendants' surrebuttal testimony, will be taken at the offices of George H. Christy, No. 110 Diamond street, Pittsburgh, Pa., commencing on Tuesday, May 8th, 1894, at 10.30 o'clock a. m. The testimony will be taken under the 67th rule in equity, and under the order of the court in this behalf.

J. SNOWDEN BELL,
Of Counsel for Complainants.

Pittsburgh, April 27th, 1894.

Due service admitted this 28th day of April, A. D. 1894.

SKIPWITH WILMER,
Solicitor for Defendants.

1340 United States Circuit Court, District of Maryland.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY *vs.* BOYDEN POWER BRAKE COMPANY; CHARLES A. BOYDEN, President; Charles B. Mann, Secretary, and William Whitridge, Treasurer.	In Equity. No. 321.

Depositions of witnesses and other evidence in reply on behalf of complainants in the above-entitled cause, taken under the 67th rule in equity and under the order of the court made March 29th, 1894, pursuant to the foregoing notice, before F. E. Gaither, notary public, as special examiner, at the offices of George H. Christy, Esq., Bakewell law building, Pittsburgh, Pa., commencing on Tuesday, May 8th, 1894, at 10.30 a. m.

Present: *J. Snowden Bell*, Esq., of counsel for complainants; *Charles B. Mann*, Esq., on behalf of defendants.

H. H. WESTINGHOUSE, being recalled in reply, deposes and says, in answer to interrogatories propounded to him by J. Snowden Bell, Esq., of counsel for complainants, as follows, to wit:

887 Q. Are you the same H. H. Westinghouse who heretofore testified in this cause?

A. I am.

888 Q. Were you present at the works of the Boyden Brake
1341 Company, Biddle and Chester streets, Baltimore, Md., on April 12th, 1894, during the making of experiments by Mr. George A. Boyden, with valve devices alleged to have been constructed in accordance with patent No. 217,838?

A. I was.

889 Q. Did you upon that occasion examine said valve devices, or either of them, and observe the experiments with sufficient attention to understand them?

A. I did.

890 Q. Have you read the testimony of defendants' witnesses, G. A. Boyden and L. J. Gwin, commencing April 4th, 1894, relatively to valve devices alleged to have been made in accordance with patent No. 217,838, and experiments made with said valve devices, and their testimony as to the same subjects-matter given April 13th, 1894?

A. I have.

891 Q. In his answer to Q. 248, Mr. Boyden, referring to the valve devices, to which and to experiments with which the testimony of himself and Mr. Gwin, specified in the last preceding question, relates, says:

"I made the devices in strict accordance with the patent 217,838, in order to shut off cavil as to their being made like the devices shown and described in the said patent."

Please state whether or not you found these valve devices to be "in strict accordance with the patent 217,838," and if not, in what

BLEED THROUGH POOR COPY

particulars you found that the instructions of said patent had been deviated from?

A. I did not find the devices made by Mr. Boyden to be in strict accordance with the instructions of patent 217,838, but, on the contrary, there were important and wide variations in those structures.

Referring to Fig. 1 of the illustration of patent 217,838, the area of piston D is about four and a half times the area of passage A. In the valve devices experimented with by Mr. Boyden, the relative areas of the corresponding piston and passage is about eighteen to one. In the figure of the patent previously referred to, the
1342 area of passage C, as compared with the area of piston D, is
about one to forty, and corresponding portions of the devices made — Mr. Boyden have relative areas of about one to eighteen. So far as I can see from the specification, or from an examination of the drawing, there seems to be no good reason why the relative proportions of the several parts as indicated in the drawings of patent 217,838 should have been departed from.

I examined one of the structures made by Mr. Boyden, and found that a considerable leakage passage had been provided past the piston D, and I regard the presence of such a leakage passage as a complete departure from the instructions of the patent, and one that would defeat the intended operation of the device.

892 Q. In view of the instructions of the specification of patent 217,838, and the showing of the drawing of said patent, and also in view of the established practice in the construction of appliances relating to fluid-pressure brake apparatus, please state whether a skilled mechanic, working from patent No. 217,838, would be led to fit up the devices of said patent so that the pistons thereof would fit as tightly in their casings as is compatible with proper operation, or whether he would be instructed or warranted in failing to make the pistons fit their casings, and in providing a considerable leakage passage around them?

A. I have been unable to find anything, in the specification or drawings of the patent in question, that would justify any departure from the usual practice of a skilled mechanic, in making a structure from the said drawings and specification. Whenever a piston is shown in a drawing as fitting a cylinder, a skilled mechanic would unquestionably understand that, in the absence of special instructions to the contrary, the piston was to be fitted to the cylinder as tightly as possible consistent with its free movement in the cylinder, and I find no instructions in the specification stating that a leakage passage is to be provided past the piston D. I do, however,
1343 observe that there are instructions which call for a construction that would require the piston D to be as tightly fitted to its cylinder as is consistent with free movement.

The last paragraph of the first page of patent 217,838 states that: "But should the pressure in the front part of the pipe communicating with A be reduced intentionally or by accident, then, the valve E closing the holes in the piston D, that piston is pressed down by the pressure from B, and the valve F is drawn from its seat, leaving

the orifice C open for the escape of air from the hinder portion of the pipe which communicates with B; and by giving the piston D and valve E a sufficient length of stroke or motion, such that it will drop below the shoulder *s*, an open passageway will be formed for the escape of fluid-pressure from the enlarged space or port s^1 to s^2, and thence out at C."

From this description it will be seen that unless piston D is tightly fitted to its cylinder, a reduction of pressure in passage A would not effect a movement of piston D, or an opening of passage C, because the leakage passage would permit the flow of air from above the piston D, thereby preventing the making of a sufficient difference of pressure on the opposite sides of piston D to cause a downward movement.

The presence of the holes *d* in the piston D, and of the valve E for closing these holes when pressure is reduced on the under side of piston D, clearly indicates that these passages were necessary to permit air to flow through the train-pipe, for the purpose of charging and releasing brakes.

Neither the holes nor the valve referred to would have been required, if a leakage passage were intended to be provided past the piston D.

The portion of the specification quoted, which states that the giving of the piston D and valve E a sufficient stroke to drop below the shoulder *s*, so that open passageway will be formed for the escape of fluid pressure from the enlarged space or port s^1 to port s^2, and thence out at C, clearly indicates that piston D should be tightly fitted and without a leakage passage; otherwise,
1344 there would have been no need for a provision for an extra length of stroke of piston D.

As heretofore stated, I have found nothing in the specification indicating that a leakage passage should be provided past the piston D, and the foregoing reasons that I have given, prove to me that there are the best of reasons why such leakage passage should not exist in the structures shown in patent No. 217,838.

893 Q. State whether or not, you find any matter, either expressed or implied, in the specification or drawings of patent No. 217,838, which would instruct, warrant, or justify the construction of such an appliance as is shown in Defendants' Exhibit- "Working Drawing, Patent 217,838, on Angle Cock" and "Tracing of Working Drawing, Patent 217,838, on Angle Cock."

A. I find absolutely nothing that describes or indicates a construction of the kind referred to.

894 Q. Defendants' witnesses Boyden and Gwin allege, in their testimony, that the pistons D were made "about" one sixty-fourth of an inch smaller than the bore of the casings in which they worked. Mr. Gwin also states that Mr. Boyden instructed him to make the pistons one sixty-fourth of an inch smaller than the bore of the casings, and that the devices were fitted up under his (Gwin's) orders by a machinist and workman. Do you find any testimony on the part of defendants, and if so, where, that these instructions were strictly complied with, or that either Mr. Boyden or Mr. Gwin

actually knows or states the precise width of the leakage space around the pistons of the valve devices?

A. I do not find any testimony of the kind stated.

895 Q. Assuming this leakage space to have been only one sixty-fourth of an inch between the pistons and the casings, what would be its area and what its capacity for permitting the passage of air without allowing the devices to be operative?

A. Assuming the leakage passage to be of the size named, it would have an area of about one-fifteenth of a square inch, and it would require an opening from the train-pipe to atmosphere
1345 with an area in excess of one-fifteenth of a square inch to insure the downward movement of piston D.

The size of opening in train-pipe that is usually employed for making all graduated applications of the brakes, has an area of about one-twentieth of a square inch.

896 Q. What, then, would be the result of adding, as you say was done, in the valve devices experimented with by Mr. Boyden, a leakage passage having an area of about one-fifteenth of a square inch, to the valve device described and shown in patent 217,838?

A. The result of such addition was to destroy the intended operation of the device of patent 217,838, except when an excessive or unusual reduction of pressure was made in the train-pipe.

897 Q. The record shows that Mr. Boyden was requested by complainants' representatives to make other and further experiments with the valve devices which he used, and that he refused to do so. Please explain why you desired these further experiments to be made, and how far they would have assisted in determining the question of the practical utility of the valve devices in an automatic brake system?

A. I requested Mr. Boyden to make an experiment with devices which he was using for the purpose of ascertaining whether an increase of train-pipe pressure, made at a slow rate, would release the brakes.

I consider this to be an important point for determination, as it frequently happens, in practice, that the restoration of train-pipe pressure for the purpose of releasing brakes is made very slowly.

The operation of the device shown in patent 217,838, requires that the flow of air into the train-pipe for the purpose of releasing the brake shall be at a fairly rapid rate, otherwise there would be no effective pressure to overcome the resistance of piston D and cause the closure of passage C. And if such movement and closure does not take place, the pressure admitted to the train-pipe
1346 will flow directly to the atmosphere, through passage C without effecting the release of the brakes.

Mr. Boyden was also requested to have new pistons made in accordance with drawings and specification of patent No. 217,838, so that the piston D should fit its cylinder tightly. The object of this request was to determine the operation of the device of the patent in question, when a leakage space was not provided around the piston D.

898 Q. Having in mind the alleged purpose of the experiment

made with these valve devices by Mr. Boyden, to what extent do you consider his reasons for refusing to make the further experiments requested, to be well founded?

A. I do not consider the reasons given by Mr. Boyden for refusing to make further tests, as well founded. It was suggested that the releasing test be made by placing the handle of the engineers' valve in what is known as the running position; in this position communication between the main reservoir and the train-pipe is considerably smaller than when the handle of the engineers' valve is placed in full release position. Mr. Boyden stated that releasing of brakes with the handle in the running position would be a more severe test than the standard brakes of today are subjected to in practice. He is mistaken as to this point, as brakes are very frequently released with the handle in running position, and in many instances, special instructions have been issued that the brakes were to be released entirely through the running-position port. It has also been proposed by a railroad officer having charge of the operation of brakes, to modify the engineers' valve so there would be but one port, and that one the running-position port, for the purpose of releasing brakes.

The tests made by the Master Car Builders' committee for the purpose of determining the practical value of different kinds of triple valves, are much more severe and exacting than the one proposed to Mr. Boyden. The port through which the air flows

1347 for releasing brakes in the tests referred to, is many times smaller than the releasing port of the engineers' valve when the handle is in running position. I no not consider the test of releasing brakes with the handle of the engineers' valve in running position as at all exacting; and I would consider a brake apparatus as entirely impracticable and useless for regular service, if it would not release under the conditions stated, particularly when the valves are clean and in perfect condition, as was presumably the case with the devices with which Mr. Boyden made his experiments.

With respect to the request that experiments be made with pistons fitting the cylinders tightly in the devices of patent 217,838, Mr. Boyden stated that he would not make these experiments, because the ones already experimented with were made in accordance with patent 217,838, and for the reason that they worked as the specification of that patent states they should work, and that they produced the result which the devices of patent 217,838 were invented to produce.

I think Mr. Boyden is entirely wrong in the reasons that he gave for refusing this request. The operation of the devices, as shown at the tests in question, was not at all in accordance with the intended operation as described in the patent. By reference to Mr. Boyden's testimony it will be seen that when the handle of the engineers' valve was placed in service position, and air was discharged for the purpose of applying brakes, there was no movement of the piston D or valve F, and consequently no discharge of train-pipe air to the atmosphere. The specification of the patent distinctly states that when the pressure in the front part of the train-

pipe is reduced it will cause movement of the piston D and the opening of passage C, for the purpose of discharging train-pipe air to the atmosphere.

The only manner in which the movement of piston D could be obtained in the experiments, was by placing the handle of the engineers' valve in a full application position, and completely
1348 exhausting the air from the train-pipe. Nothing whatever
in the specification of patent 217,838 calls for such a mode of operation, or for modifications in the structure of the patent that would cause the device to operate in the manner shown in the experiments in question.

I have already referred to the deviations from the directions of the patent, in the devices made by Mr. Boyden, and in view of these facts and the results of the tests as I witnessed them I think Mr. Boyden is fully and entirely wrong in stating his reasons for not making the tests as requested.

899 Q. If I understand your last preceding answer correctly, in the use of the valve devices experimented with by Mr. Boyden, a full application of the brakes was effected, without opening the release passages C of said valve devices. Am I right or not?

A. Your understanding of their mode of operation is correct.

900 Q. Is it or not possible to effect a full application, or any application, of the brakes, under the terms of patent 217,838, and using valve devices made in accordance with the instructions of the specification and drawing of said patent, without opening the release passages C of said valve devices?

A. If the valves are constructed in accordance with the drawing and specification of the patent, it would be impossible to get any application of the brakes without the movement of piston D and the opening of the port C.

901 Q. Is it or not the fact that, in the use of the valve devices employed by Mr. Boyden in his experiments, there were two distinctly different applications of the brakes, to wit, one a full application, in which the valve devices alleged to be in accordance with patent 217,838 were not operative, and another and a quicker application, in which they were operative?

A. There were two distinct modes of operation, which you have correctly described.

902 Q. Is the capacity of the two kinds of application of
1349 the brakes mentioned in the last preceding question, specified or provided for in patent 217,838, or possible under the construction of that patent?

A. No.

903 Q. Was the capacity of two kinds of application of the brakes, one by the ordinary appliances, and another and a quicker application by other appliances, known in the art at the date of the patent No. 217,838?

A. So far as I am aware of, it was not.

904 Q. Taking the valve device as you saw it experimented with, as changed and modified by Mr. Boyden in the particulars you have stated, and in view of the results produced by Mr. Boyden, what is

your opinion as to the practical merit or value of said valve device for actual use in controlling freight trains on railroads?

A. I agree with the opinion expressed by Mr. Boyden in answer to X Q. 348, that the device, as he used it, would not be acceptable to railroad officials for practical use.

905 Q. To what extent, if at all, would your opinion be modified if the valve device was constructed in strict accordance with patent No. 217,838, instead of deviating therefrom, as used by Mr. Boyden, in the particulars you have specified?

A. Not in any respect.

906 Q. Mr. Boyden admits, in answer to X Q. 305, that it is the fact that long prior to the institution of this suit, he, himself, recognized the obvious practical inoperativeness of the device of patent 217,838. To what extent do you concur in Mr. Boyden's recognition of the obvious practical inoperativeness of this device?

A. I fully concur with him.

Adjourned to meet on Wednesday, May 9th, 1894, at 10 a. m.

1350 WEDNESDAY, *May 9th*, 1894.

Met pursuant to adjournment at 10 a. m.

Present: Counsel as before.

Cross-examination by CHARLES B. MANN, Esq., on behalf of defendants:

907 X Q. State whether your testimony given yesterday relative to the operation of the device of patent No. 217,838 is based on theory and reasoning, or on the demonstration of actual tests made by you?

A. My testimony was based upon a careful examination of the specification and drawings of the patent, and upon the experiments that I witnessed that were made by Mr. Boyden.

908 X Q. Then, you have not made and tested valve devices constructed in accordance with patent 217,838?

A. I have made and tested valves made in accordance with patent 217,838.

909 X Q. State whether or not you understand patent 217,838 has for its object to provide valve devices, by use of which the material advantage could be effected of having all the brakes of the train applied or brought into action simultaneously, or as nearly so as possibly?

A. In a general way, I understand the object of the patent in question to be as stated in the question.

910 X Q. In your answer to Q. 891 you state that there are important and wide variations between Fig. 1 of the drawing of patent 217,838, and the valve devices made and tested by Mr. Boyden. You say, in substance, first, that Mr. Boyden's valves have passages A with area relatively smaller than the pistons D, as compared with the said patent drawing; second, that the area of passages C are relatively larger than the area of the pistons D, as compared with said patent drawing, and, third, that the pistons D were made

smaller than the casings to provide a leakage passage. I now as you if the devices made by Mr. Boyden were substantially like Fi 1 of the drawings of the patent, with the exception of your thr alleged variations?

1351 A. The devices made by Mr. Boyden that I saw had the ge eral form and appearance of the structure shown in Fig. of the patent. I made personal examination of only one of the devices, and it seemed to be made in accordance with the blue pri which is one of the defendants' exhibits.

911 X Q. As to the first of the three variations you mention, you not think that the purpose of Mr. Boyden could have been endeavor to preserve the general proportions of the device as th appear in Fig. 1 of the patent, and at the same time have the pa of a size that would fit the hose coupling on his test-rack?

Objected to as incompetent, it being obviously impossible for t witness to divine what Mr. Boyden's purpose was in deviating fro the patent.

Counsel for defendants replies that the question has reference a variation which the witness has referred to as existing betwe the valves as made by Mr. Boyden and Fig. 1, as in the pate The question does not ask the witness if he could divine what M Boyden's purpose was, but simply inquires, if a certain stated pu pose could not, in the opinion of the witness, have been the purpo that actuated Mr. Boyden in changing the proportions of t passage A and piston D.

A. It is impossible for me to say what Mr. Boyden's object w in departing from the instructions of the specification and drawi of patent No. 217,838 in the manner that he did.

With reference to the particular variation asked about, I cann see that making the piston D relatively larger than the passage as compared with the proportions shown on the drawing of t patent, in any way facilitated or affected the fitting of his device the hose couplings that he used, for the reason that t

1352 cylinder in which the piston D moves is considerably abov and not at all limited by, that portion of the structure whi screws into the hose coupling.

912 X Q. As to the second of the three variations you mentio do you not think it quite reasonable that the purpose Mr. Boyd could have in making the escape passage C relatively larger th it is shown in the patent drawing, was on account of the larger-si train-pipe that is now used with air brakes, as compared with t size of the train-pipe that was used in the year 1879, his test-ra being equipped with the larger-size pipe?

A. As previously stated I cannot know what purpose Mr. Boyd had in making the variations in the structure of patent 217,838 th he did make on the devices that I saw tested in his works at Bal more; it, however, seems entirely unreasonable to me that he shou have carried out his experiments with devices essentially differe from the kind described in the patent, having widely varying pr portions as compared with those shown in the patent, and testi

these devices upon a rack with a train-pipe of a size that was not known or used in regular air-brake practice at the time of the invention of the device in question, and for nearly eight years subsequent to its issue. The size of train-pipe that was in use at the time the device in patent 217,838 was invented, was three-quarters of an inch in diameter, and each car had a length of about sixty feet; the size of train-pipe that Mr. Boyden used in his test is of inch and a quarter diameter, and each car has a length of about forty feet, and this larger pipe came into use about the year 1887. The reasonableness of the variation referred to that was made by Mr. Boyden, does not appear to me, as the increase of the capacity of the train-pipe was about doubled as compared with what was in general use in 1879, while the increase in the size of opening used in the devices tested by Mr. Boyden, was about in the proportion of ten to one.

913 X Q. As to the third of the variations you mention,
1353 do you not think it quite reasonable that the purpose Mr. Boyden could have in making the pistons D one sixty-fourth of an inch smaller than the casings in which they moved, was to avoid the liability of the pistons' sticking, due to grit or sediment, of which more or less is usually contained in train-pipes?

A. I regard the presumption stated as entirely unreasonable, because it is not at all likely that the modification described would remedy the supposed objection. I cannot conceive that it is reasonable to make any modification in a structure that will destroy its intended operation, and there are much better methods of overcoming the suggested trouble than the making of a loose-fitting piston.

914 X Q. In the construction of appliances relating to air-brake apparatus, where it is desired to have a piston fit a cylinder so as to prevent leakage, is it not the usual practice to provide the piston with a packing ring?

A. It is the usual practice.

915 X Q. Has the piston D in the drawings of patent 217,838 any packing ring?

A. No.

916 X Q. Is it not a fact that, in the tests you saw Mr. Boyden make in Baltimore on April 12th, 1894, that in the *fifth* test thereof, as testified to by Mr. Boyden, when the engineers' valve was placed in position for an emergency application, all the fifty brakes on the test-rack applied in ten and a half seconds, and the air was discharged from the train-pipe through the passage C of the valve devices of patent No. 217,838?

Objected to as immaterial, it appearing by the testimony of the witness that the experiments made by Mr. Boyden at Baltimore were made with valve devices not in accordance with patent 217,838, and the results of such experiments, therefore, not being material. And further objected to as not proper cross-exami-
1354 nation, and as embodying the assumption that the valve devices experimented with *were* in accordance with patent 217,838.

A. The devices tested by Mr. Boyden worked substantially in the manner described in his testimony, with respect to the fifth test.

917 X Q. In the fifth test made by Mr. Boyden, which you saw, the application of the fifty brakes was quickened, was it not, by the discharge of the train-pipe air through the passages C of the valve devices he used?

Objected to as immaterial, for the reason stated in the last preceding objection.

A. It was.

918 X Q. The valves used by Mr. Boyden in the tests made by him, and which in the fifth test caused the brakes to apply quicker by discharging the train-pipe air through the passages C, were the same valves, were they not, which you have criticised because the pistons D fit so loose as to form what you say are considerable leakage passages?

A. Yes.

919 X Q. You say in answer to Q. 892:

"From this description it will be seen that, unless piston D is tightly fitted in its cylinder, a reduction of pressure in passage A would not effect a movement of piston D or an opening of passage C."

In view of the fact that the valves you saw Mr. Boyden test did open to discharge train-pipe air from the passages C, is it not evident that the pistons D of those valves fitted as tight as the patent 217,838 contemplated?

A. They undoubtedly did not fit as tight as the patent contemplated, for the reason that the tests made by Mr. Boyden showed conclusively that a reduction of pressure could be made in passage A, sufficiently great to set all the fifty brakes with full force,
1355 without the movement of piston D. The patent specifically states that, should the pressure in the front part of the pipe communicating with A be reduced intentionally or by accident, the piston D will be pressed down and the valve F withdrawn from its seat.

920 X Q. You say in answer to Q. 892:

"From this description it will be seen that unless piston D is tightly fitted in its cylinder, a reduction of pressure in passages A would not effect the movement of piston D or an opening of passage C."

In view of the fact that the valves you saw Mr. Boyden test on April 12th did open to discharge train-pipe air from the passages C in the fifth test, where the brakes were to be applied quickly, is it not evident that the pistons D of those valves fitted as tight as the patent 217,838 contemplated?

Objected to as fully answered in reply to X Q. 919, wherein the witness states that the valves undoubtedly did not fit as tight as the patent contemplated, and gives his reason shown by the tests made by Mr. Boyden.

Counsel for defendants objects to the objection as being useless

d improper and in the nature of testimony, and because if the tness believed and understood that the question as last presented, d which differed from the former question, had been fully an-ered, it was proper for him alone to say so.

Counsel for complainants suggests that the propriety of objections n be best determined by the court.

A. They did not fit as tightly as the patent contemplated, for the ason already stated, namely, that previous tests showed that a mplete exhaustion of train-pipe pressure could be made and e brakes set with full force without causing the opening of the ssages C.

921 X Q. Was the previous test made by Mr. Boyden, to
356 which you refer, the one he has designated "second," where the engineers' valve handle was placed in the "graduating osition?"

A. Yes.

922 X Q. Please to point out, if you can, in the specification of atent 217,838, any direction that the proportions of the parts as hown in the drawings, or the fits of the parts, shall be adhered to.

A. Referring to the specification, I find this statement: "And I do ereby declare the following to be a full, clear, concise and exact escription thereof, reference being had to the accompanying draw-ngs making a part of this specification." And I also find the follow-ng matter contained in the specification: "The form or construction f the relief valve, its function and operation being substantially etained, may be varied considerably, in so far as it is an element n the described combination, without any material departure from he scope of the invention."

It seems perfectly clear to me that these instructions and state-nents clearly indicate that the functions and proportions of the evice, as described and illustrated, are to be retained, whatever hanges may be made in its form or mode of construction.

A reference to the drawings also clearly shows that they are uitable for working drawings, and were probably copied from them, nd there is no reason to believe that valves made in accordance vith these drawing- would not operate substantially in accord-ance with the description of the patent.

923 X Q. Referring to your answer to Q. 896, I ask what "in-ended operation of the device of patent 217,838" was destroyed, s you say, by making the pistons D one sixty-fourth of an inch smaller?

A. The downward movement of piston D and opening of piston C, when a reduction of pressure was made in the front of the train-pipe communicating with passage A, except when excessive or nusual reduction of pressure was made in the front of the train-pipe.

924 X Q. Is the excessive or unusual reduction of pressure
1357 made in the front end of the train-pipe, such a reduction as was made by the engineers' valve in the year 1879, when the

engineer desired to apply the air brakes in the shortest time and with the greatest power?

A. Yes.

925 X Q. Then I understand from your testimony that the valve devices which Mr. Boyden tested in your presence, would not open the passages C when the engineers' valve handle was placed in the graduating position to slowly apply the brakes, but that said passages C did open when the engineers' valve handle was placed in the emergency position to quickly apply the brakes with full forces; am I correct?

A. In the experiments made by Mr. Boy*nton* the brakes were applied with full force when the handle of the engineers' valve was placed in graduated position, but there was no opening of the passages C with the handle of the engineers' valve in this position. The brakes were applied with full force, and more quickly, when the handle of the engineers' valve was placed in the emergency position and air escaped from the passages C from the train-pipe to the atmosphere.

926 X Q. In the graduating test made by Mr. Boyden, when the engineers' valve handle was placed in the "graduating position," and then blanked, were not the brakes gradually and partially applied?

A. They were.

927 X Q. Then my last previous question 925 could have been correctly answered by a simple affirmative response, could it not?

A. I think it is more completely answered in the response made to that question, as I desired to have it clearly understood that a full application of the brakes was made with the handle of the engineers' valve in the graduating position, as well as in the emergency position.

It might have been inferred from the question that a full application of the brakes was not obtained with the handle of the engineers' valve in the graduating position.

1358 928 X Q. In your answer to questions 897 and 898, you state that "brakes are very frequently released with the handle of the engineers' valve in the running position." Now, I ask, would you, as an officer of the Westinghouse Air Brake Company, recommend the practice of releasing the brakes in a fifty-car train, when using a Westinghouse engineers' valve, like that used by Mr. Boyden in his tests, by placing the handle of the engineers' valve in the running position, and not in the full release position?

A. I should not recommend the use of the port of the running position of the engineers' valve used by Mr. Boyden in his tests, under all circumstances, for the purpose of releasing brakes on a fifty-car train, but it certainly can be used to very great advantage, for the purpose of releasing brakes under the conditions named, and in regular practice is made use of for that purpose. I certainly should not consider valve devices that could not be released on a fifty-car train by the use of this method of releasing brakes, to be of any practical value, particularly when operated under the conditions that existed when Mr. Boyden made his tests.

929 X Q. Do you not, in any of your books of instruction or escriptive catalogues of air brakes, as issued by your company, istinctly state, that the handle of the engineers' valve should be laced in the full release position, and after the brakes have released, eturn the handle to the running position?

Objected to as immaterial.

A. Our most recent printed instructions state that on trains of noderate length, the brakes can be released and auxiliary reservoirs echarged, by placing the handle of the engineers' valve in running osition. Previous publications have instructed engineers to handle he valve substantially in the manner described in your question.

930 X Q. In your answer to Q. 898, you give ex-
359 & 1360 pression to your views as to how different parts of the air brake should operate; this testimony has reference, as it not, to the superior air brakes that are in use at this present ime?

A. In reading over the answer of the question referred to, I find hat any opinions that I expressed in that answer, relative to the vorking of air brakes, were intended to apply to automatic brakes s they were made in 1879.

931 X Q. Please state whether the engineers' valve which you saw Mr. Boyden use in the tests he made, and which you referred to in your answer to Q. 898, was the kind of engineers' valve that was in use in the year 1879?

A. It was not.

932 X Q. Then so much of your answer to Q. 898 as related to the working of air brakes by this engineers' valve, was not intended to apply to automatic brakes as they were made in 1879. Am I not right?

A. The answer in question was not given for the purpose of stating any particular method of operating any particular kind of brake at any particular time. What I wished to express, in a general way, was the fact that automatic brakes in good condition should be readily released by a very moderate increase of pressure in the train-pipe. It is a matter of no importance what kind of an engineers' valve is used for this purpose.

H. H. WESTINGHOUSE.

Adjourned *sine die*.

1361 *Opinion.*

Filed March 11, 1895.

In the Circuit Court of the United States for the District of Maryland.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY *vs.* THE BOYDEN POWER BRAKE COMPANY.	In Equity.

MORRIS, *District Judge:*

This is a bill in equity, in usual form, charging the defendant with infringing the Westinghouse patent No. 360,070, dated March 29, 1887, for a fluid-pressure automatic brake mechanism.

The claims alleged to have been infringed by the defendant, are claims 1, 2 and 4, which are as follows:

"1. In a brake mechanism, the combination of a main air pipe, an auxiliary reservoir, a brake-cylinder, a triple valve, and an auxiliary-valve device, actuated by the piston of the triple valve and independent of the main valve thereof, for admitting air in the application of the brake directly from the main air pipe to the brake-cylinder, substantially as set forth.

"2. In a brake mechanism, the combination of a main air pipe, an auxiliary reservoir, a brake-cylinder, and a triple valve having a piston whose preliminary traverse admits air from the auxiliary reservoir to the brake-cylinder, and which by a further traverse admits air directly from the main air pipe to the brake-cylinder, substantially as set *set* forth.

"4. The combination, in a triple-valve device, of a case or chest, a piston fixed upon a stem and working in a chamber therein, a valve moving with the piston stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere respect-
1362 ively, and an auxiliary valve actuated by the piston stem and controlling communication between passages leading to connections with a main air pipe and with the brake-cylinder, respectively, set forth."

The only defence now urged by the defendant is non-infringement.

The history of the pioneer inventions of George Westinghouse, Jr., in fluid pressure brakes, by means of which the brakes of a train of railroad cars can be operated by air pressure controlled by the engineer of the train, and the history of the successive steps and inventions by which he has devised mechanisms adapted to apply that power so as to act automatically on each car, and the scope and fundamental importance of his later inventions by which he has accelerated in an astonishing degree, the quickness with which the brakes can be applied almost simultaneously on each car of a long

train consisting of as many as fifty freight cars, has been carefully and fully stated by Judge Townsend, who delivered the opinion in the case of Westinghouse *vs.* New York Air Brake Co., 59 Fed. Rep. 962, and in the opinion of Judge Lacombe, filed December 27, 1894, in a case between the same parties in the United States circuit court for the southern district of New York.

The patent now in suit, No. 360,070, March 29, 1887, is the first of the Westinghouse patents in which he describes an additional function engrafted upon his automatic air brake, which is intended to be used only in cases of unusual emergency and which is intended to meet the difficulties of applying air brakes quickly on long trains. The purpose of the device was to increase the quickness of the serial action of the automatic brake mechanism on each successive car by making the triple-valve device of each brake mechanism set in operation the valves on the car immediately in its rear, and at the same time to make use of the train-pipe air vented for this purpose from the train-pipe at each triple valve, so as to add its power to the power supplied from the auxiliary reservoir of each car.

The result which Westinghouse was seeking in the new device described in patent No. 360,070, was first and princi-
1363 pally to vent the train-pipe at each car so as to quicken the serial action of the brakes from car to car; and, secondarily, to utilize the vented air and not waste its power.

Westinghouse discovered that he could accomplish this result by so constructing the ordinary triple valve of his automatic mechanism that, in an emergency, the engineer by widely opening his engineers' valve, and thereby causing sudden and unusual release of pressure in the train-pipe could cause the piston of the triple valve to make an unusual and further traverse and thereby actuate a valve, which opened a port by which the train-pipe air was admitted suddenly and directly into the brake-cylinder, without passing through the auxiliary reservoir.

This sudden release of air from the train-pipe vented that pipe at the first car, and that venting in like manner released the pressure in the train-pipe at the valve of the next car, and so on from car to car with almost instantaneous rapidity.

It is shown that this device, as first constructed, was not entirely successful. It applied the brakes with greatly increased serial rapidity as compared with any former device and with much greater power, but not so quickly—but that the rear cars impinged against the forward ones with destructive shocks.

The reason for this appears to have been that the operation of venting was not carried far enough, because the port opened by the auxiliary valve was not of sufficient size and did not release the full volume of train-pipe air suddenly enough to vent it sufficiently. This defect was remedied by an improved mechanism devised by Westinghouse and described in his patent No. 376,837, January 24, 1888.

The success of this improved device has demonstrated that the invention by which the further traverse of the triple-valve piston

beyond the extent of the traverse required for the ordinary application of the brakes is made to admit a large volume of train-pipe air directly to the brake-cylinder was one of great importance.

1364 The proofs show that a quick-action automatic brake, which would give the results which this brake has accomplished, was eagerly sought after by inventors and car-builders, and all had failed, until Westinghouse discovered that it could be done by this mode of operation.

In the cases above referred to, in which this patent, No. 360,070, and the improvement on it, No. 376,837, were discussed with reference to the state of the art and the scope of the invention therein disclosed, these were held to be patents of a fundamental pioneer class describing an invention of primary importance.

In those cases the defendants, who were charged with infringing, were using a separate and independent valve to open the port to the train-pipe, and the question was whether or not Westinghouse was restricted to the form of independent valve and the precise mode of actuating it set out in his patent. It was held that he was entitled to a liberal construction of his claims, and that, in respect to the emergency valve, the form of his device was not of the essence of his invention.

In the Boyden mechanism, which is alleged in this case to infringe, I have not been able to satisfy myself that Boyden makes use of an auxiliary valve in the sense in which that term is employed in the specification and in some of the claims of the patent No. 360,070, now in suit.

It appears from the specification of patent No. 360,070, that what Westinghouse meant by the auxiliary valve, which is made one of the elements of the combination in the first and fourth claims, is such a valve as he has described in his specification, and which is independent of and performs none of the functions of the main valve of the ordinary triple-valve device, and I am not satisfied, notwithstanding the very positive testimony of the complainants' experts, that the poppet valve 22 of the Boyden mechanism is such a valve, for Boyden's poppet valve 22 does, as I understand its operation, to some extent perform the functions of a main valve of the triple valve, as well as the function of Westinghouse's auxiliary quick-action or emergency valve.

1365 It is probably true that in the Boyden mechanism, the stem valve *i, k, j*, which I take to be the equivalent of the sensitive graduating valve shown in the Westinghouse patent No. 220,556, October 14, 1879, is so constructed that it may do, and probably in most cases does do, the work of ordinary breaking, that is to say, that by two or three successive applications of pressure through that smaller and more sensitive valve the brake-cylinder is filled and the main valve 22 becomes non-essential, or, if lifted off its seat, is moved very gently; but valve 22 will, if the engineer uses his brake-valve carefully, do the work of a main valve, as is demonstrated, I think, by the experiments in which the sensitive graduating valve *i, k, j*, was plugged up. So I take it that defendants' valve *i, k, j*, must be held to be the sensitive graduating valve

usual in triple-valve devices since the Westinghouse patent No. 220,556; and the defendants' valve 22 must be considered to be the main valve, and that in defendants' mechanism he has been able, by an ingenious arrangement restricting the admission of auxiliary reservoir air to the triple-valve chamber, to cause the main valve to do both main valve work, when needed, and to do quick-action work when needed.

As by the explicit terms of claims 1 and 4, Westinghouse has restricted himself, as to those claims, to an auxiliary valve independent of the triple valve, I hold that the defendant does not infringe those claims.

Claim 2.

Claim 2 reads as follows:

"2. In a brake mechanism, the combination of a main air pipe, an auxiliary reservoir, a brake-cylinder, and a triple valve having a piston whose preliminary traverse admits air from the auxiliary reservoir to the brake-cylinder, and which by a further traverse admits air directly from the main air pipe to the brake-cylinder, substantially as set forth."

The first three elements of this claim are the usual mechanism of an automatic air brake; the remaining element, which was the only novel one at the date of the patent, is a triple valve
1366 having a piston which by two distinct movements performs two distinct functions, the first its preliminary traverse by which it admits air from the auxiliary reservoir to the brake-cylinder, which is the ordinary effect of the usual movement of the triple-valve piston, and the second, its further traverse, which is a new and distinct use, admitting air directly from the main air pipe to the brake-cylinder, resulting in venting the main air pipe and in producing the quick action.

Now this, as I understand it, was the invention which Westinghouse brought to light. He discovered, and by experiment demonstrated, that by a further traverse of the triple piston train-pipe air could be vented from the train-pipe and that it would give two very important results, namely, first, quickening of the action of the brakes from the forward to the rear cars, so that the application of the brakes became almost instantaneous on all the cars, and, second, utilizing the vented air for direct action in the brake-cylinder. Now, although quick-action emergency brakes were being sought for, no one before Westinghouse had accomplished this result, and the means by which he accomplished it were entirely novel. Indeed, upon first impression it is paradoxical and startling to find that when a sudden, quick and powerful application of brakes is needed in the face of impending danger, it is to be obtained by a sudden large release of the pressure in the train-pipe, to the extent of fifteen or twenty pounds below that in the auxiliary reservoir, and that by using this low-pressure air to operate the brake-cylinder, instead of the air under greater pressure stored in the auxiliary reservoir, this remarkably effective application of the brakes is obtained. In the domain of quick-action brakes, this device would

seem to belong to that class of pioneer inventions, the patents for which are to be construed so as to be coextensive with the real invention, if the language of the claim will permit it.

It is shown that Westinghouse was the first who used a further traverse of the triple-valve piston to perform the operation required to vent the train-pipe into the brake-cylinder, to effect quick action. The result was new and the means were new. His claim 2 is broad enough in language to cover every device in which that is
1367 done by the further traverse admitting air directly from the
train-pipe to the brake-cylinder, substantially by the means described in the specification, that is, by the further traverse actuating a valve which so admits the train-pipe air.

The result accomplished by defendant's mechanism is identical with that of Westinghouse, and the means by which the mechanism is actuated so alike that in its published trade catalogue defendant claims that cars fitted with its valves can be used on the same trains with the Westinghouse quick-action brake, because the engineer in applying or releasing the air pressure may treat them as identical; the same functional operations of the valves and the same results being obtained from the same changes in the engineers' brake-valve, so that there is strong *prima facie* reason to suppose that Boyden's way of using the same release of pressure to vent the train-pipe and to actuate the valves, which produces identical results, may be Westinghouse's way.

In mechanisms actuated by air under pressure, the transmission of power is not visible to the senses as plainly as when it is done by cranks and levers, and being transmitted by an invisible agency in all directions in which the air can escape, the functions of the instrumentalities by which it operates are more important than their forms, and in judging of an infringement we are to direct our minds rather to functional equivalents than mechanical equivalents.

The use by Boyden of a central opening through the triple-valve piston to admit train-pipe air to the triple-valve chamber was not new, nor the use of a poppet valve for the main valve of the triple, both of these constructions having been shown in the Westinghouse patent No. 141,685, August 12, 1873, and in others of his patents. So that there is nothing in the Boyden device not before exhibited in some one of the Westinghouse patents, except that he has been able to cause one of the valves of the triple (valve 22) at one stage of the application of brakes to perform ordinary service work, and at another to do quick-action works. This Boyden does by ingenious construction not before used, by which he restricts the passage of auxiliary reservoir air into the triple-valve chamber, so
1368 that when the further traverse of the piston suddenly unseats
the poppet valve 22 the port opened by it to the brake-cylinder is so large and the supply of auxiliary reservoir air through the restricted passage so feeble, that the train-pipe air raises its check-valve and vents itself into that chamber and thence through the large port to the brake-cylinder. For the mechanism embodying this ingenious contrivance by which the poppet valve 22 is made capable of doing ordinary service work by a careful intermittent,

slow release of pressure by the engineer, and quick-action work by a quick sudden release, patents were granted to Boyden (No. 481,134, August 16, 1892, and No. 481,135, August 16, 1892); but if this construction contains the underlying invention of the patent in suit, which was granted March 29, 1887, Boyden cannot make use of his improvement during the life of that patent.

It is true that in searching for some device which would give quick action, Westinghouse had, before the date of the patent in suit, conceived the idea that it might be accomplished by venting the train-pipe at intervals along the train. He had tried having two or three vents at intervals in the length of the train controlled by electrical apparatus, and also had tried relief valves placed in pipe coupling of each car which would open to the atmosphere and vent the train-pipe quickly in case of accident or other sudden release of pressure in the forward part of the train. This was shown in the Westinghouse patent No. 217,838, July 22, 1879, but neither of these attempts were successfully applied, and they did not solve the problem of quick action.

The problem was not solved; indeed, the first step in the direction of solving it does not appear to have been taken until the experiments which led to the Westinghouse patent now in suit. The substance of the method then devised is the use of the sudden further traverse of the triple-valve piston to open a valve in a manner different from the valve opening made by the preliminary traverse for service braking, thereby admitting train-pipe air to the brake-cylinder without its passing through the auxiliary reservoir.

In the Westinghouse apparatus the further traverse of the triple-valve piston causes it to impinge against an additional sepa-
1369 rate valve which admits the train pipe air. In Boyden's apparatus used by the defendant, the further traverse pulls the poppet valve 22, which Boyden substituted for the ordinary main valve of the triple, suddenly off its seat, thereby, in the manner before mentioned, causing the train-pipe air to raise the check-valve and flow with volume through the triple-valve chamber direct to the brake-cylinder. The device in Boyden's apparatus, by which the difference of pressures in the triple-valve chamber between auxiliary reservoir air and the train-pipe air is produced and used, is ingenious and admirable; but the result obtained is just the same as when in the Westinghouse apparatus the auxiliary valve is unseated, and the means used are, in my judgment, functionally equivalent.

Under the ruling of Morley Machine Co. *vs.* Lancaster, 129 U. S., 263, and of the many cases cited in the opinion delivered in that case, the rights of a pioneer inventor are infringed by one who accomplishes the same result by means which, although never used for that purpose before, are mechanical equivalents for the means used by the inventor under a liberal construction of his patent. It was said in that case by Mr. Justice Blatchford (page 273): "Where an invention is one of a primary character and the mechanical functions performed by the machine are, as a whole, entirely new, all subsequent machines which employ substantially the same

means to accomplish the same results are infringements, althou the subsequent machine may contain improvements in the separa mechanisms which go to make up the machine."

In McCormick *vs.* Talcot, 20 How., 402, the controversy aro over a device which McCormick had added to his reaper called divider, intended to separate the standing grain to be left from th which is to be cut. The court said: "If he be the original invent of the device or machine called the divider, he will have the rig to treat as infringers all who make dividers operating on the sa principle and performing the same functions by analogous mea or equivalent combinations, even though the infringing machi be an improvement of the original, and patentable as such."

In Machine Co. *vs.* Murphy, 97 U. S., 120–125, it was said: "N is it safe to give much heed to the fact that the correspon
1370 ing device in two machines organized to accomplish the sa
result is different in shape or form the one from the other, it is necessary in every such investigation to look at the mode operation or the way the device works, and at the result, as well at the means by which the result is attained."

The language of the Supreme Court in Consolidated Valve C *vs.* Crosby Valve Co., 113 U. S., 157–171, is applicable:

"The prior structures never effected the kind of result attain by Richardson's apparatus because they lacked the thing whi gave success. * * * Taught by Richardson, and by the use his apparatus, it is not difficult for skilled mechanics to take pri structures and so arrange and use them as to produce more or le of the beneficial results first made known by Richardson."

It is true that a patentee can claim nothing beyond the scope his patent (Keystone Bridge Co. *vs.* Phœnix Iron Co., 95 U. S., 27- but the scope and meaning of a broad claim in the patent can on be interpreted by an understanding of the real scope of the inve tion itself.

If the Westinghouse patent now in suit is for an invention of primary character, and if the gist of that invention is the use the further traverse of the triple-valve piston to open a valve whi admits air directly from the train-pipe to the brake-cylinder, wit the result that the train-pipe is vented and the train-pipe air utilize then it appears to me that the defendant cannot exculpate itself fro the charge of infringement by the fact that in its device the trai pipe air is admitted through the triple-valve chamber and n through a by-passage, nor by the fact that in its device the furth traverse of the piston opens the main valve in a special manne which produces the same result, but does not make use of a sep rate auxiliary valve, provided Westinghouse has not by the explic terms of his claim 2 restricted himself to the use of an auxilia valve.

I do not think Westinghouse has so restricted himself in clai 2, although he does appear to have done so in claims 1 and 4.

There is without question some difficulty and embarrassment in t
broad construction of claim 2, growing out of the proceedin
1371 in the Patent Office, as shown by the file-wrapper and co

tents; but considering what was the real invention, I am not of the opinion that the legal effect of those proceedings is to restrict claim 2 to a device containing a separate auxiliary valve.

From the contents of the file-wrapper it appears that, as the application was prepared, the first claim of patent No. 360,070 differed from that which now appears in the patent as granted.

The claim 1 first proposed was: "1. In a brake mechanism the combination of a main air pipe, an auxiliary reservoir, a brake-cylinder, a triple valve provided with a device for admitting air directly from the main air pipe to the brake-cylinder, substantially as set forth."

It was objected by the Patent Office examiner that this claim and also claim 2 were anticipated by patent No. 280,285, to G. A. Boyden, June 26, 1883, and the examiner requested that a working model of the triple valve should be furnished.

Boyden's patent of 1883, No. 280,285, was a form of triple-valve mechanism intended for use with Westinghouse's automatic air brake, the object of which was to provide for replenishing the auxiliary reservoir of each car when the pressure therein had been lessened by leakage and while the brakes remained applied. This was done by the engineer causing, not a release, but a slight increase of the pressure in the train-pipe air, which, acting upon a check-valve in the centre of the triple-valve piston, by a peculiar arrangement of the valves, caused train-pipe air to pass together with auxiliary reservoir air to the brake-cylinder. The object, function and result of whatever was new and patentable in this Boyden device was altogether different from the object, function and result of the Westinghouse device in patent No. 360,070, and there seems to be no analogy or comparison which can be made between them.

It is true that the "always-open one-way passage" in the Boyden patent which, when the check-valve was raised, allowed train-pipe air to reach the brake-cylinder, was, in the language of the cancelled claim 1 of No. 360,070, "a device for admitting air directly from the main air pipe to the brake-cylinder," and there were

1372 other devices used by Westinghouse himself which this

wording would include; and the claim was, therefore, justly open to the criticism of the patent examiner, but there was no similarity in the means by which the two devices were actuated, no similarity in the object to be accomplished and no similarity in the mechanical principle of operation. It was simply a fact that there did exist in the Boyden device a passage for train-pipe air direct to the brake-cylinder which the engineer could cause to open by a slight increase of train-pipe pressure; but there was no hint or suggestion of the important discovery how that fact could be utilized to accomplish the entirely new function necessary to create a quick-action brake when, in an emergency, quick action was needed; and how, when quick action was needed, it should not interfere with ordinary graduation and service stops. This Boyden device was not in the direction of quick action, but its opposite.

While, therefore, it was proper that Westinghouse's original claim 1, should be corrected so as to express more definitely his

real invention, this was not because the Boyden patent in an manner whatever anticipated that invention or suggested it in an of its functions.

For the same reason there was then inserted in the specificatio of the Westinghouse patent No. 360,070, this clause:

"I am aware that a construction in which 'an always-open on way passage' from the main air pipe to the brake-cylinder uncovered by the piston of the triple valve simultaneously wit the opening of the passage from the auxiliary reservoir to the brak cylinder has been heretofore proposed, and such construction, whic involves an operation different from that of my invention, I therefo hereby disclaim."

In the Boyden infringing device now used by the defendant, th passage from the main air pipe to the brake-cylinder is not "u covered by the piston of the triple valve simultaneously with th opening of the passage from the auxiliary reservoir to the brak cylinder;" if it was, the defendant's mechanism would be alwa a quick-action brake and never anything else, but, on the contrar in the infringing device, the passage is not opened until there ha
been a sudden further traverse of the piston, which the
1373 brings it into operation for the distinct purpose of quic
action. The statement of the so-called disclaimer is strictl true that the construction of the Boyden 1883 patent "involves a operation different from" the Westinghouse invention, and the s called disclaimer in reality disclaims nothing which has relation t the Westinghouse quick-action invention.

The disclaimer was substituted in the place of the followin which had been in the specification and was cancelled:

"Further, while in the specific construction described and show the function of admitting air from the main pipe is performed by valve separate from that which effects the preliminary admission reservoir pressure to the cylinder, a modification in which the sam office is performed by a valve integral with the main valve an formed by an extension thereof, would be included in and embod the essential operative features of my invention."

The testimony tends to prove that this clause of the specificatio was taken out because the examiner objected that no such form triple valve was illustrated in the drawings. For whatever reaso it may have been cancelled, it is not a necessary result that the pa entee is precluded from claiming that his patent covers other form of valve integral with the main valve, if such is his legal righ when his invention, as disclosed in his patent, is found to be broad one, and if he is not restricted by his claims and if he ha done nothing to impair his right to be protected in his whole in vention. The effort should be to preserve, rather than to forfei the inventor's rights.

Keystone Manufacturing Co. *vs.* Adams, 151 U. S., 144.

The object and scope of the invention and the means employe to effect his object are thus stated by Westinghouse in the specifica tion of his patent in suit.

"The object of my invention is to enable the application of brake-shoes to car wheels by fluid pressure to be effected with greater rapidity and effectiveness than heretofore, more particularly in trains of considerable length, as well as to economize compressed air in the operation of braking by utilizing in the brake-
1374 cylinders the greater portion of the volume of air which in former practice was directly discharged into the atmosphere. To this end my invention generally stated, consists in a novel combination of a brake-pipe, an auxiliary reservoir, a brake-cylinder, and a triple-valve device governing, primarily, communication between the auxiliary reservoir and the brake-cylinder; and, secondarily, communication directly from the brake-pipe to the brake-cylinder."

This language exactly describes the infringing mechanism of the defendant.

The amendments made to meet the objections of the patent examiner are not to be construed to disclaim the patentee's actual invention, if such construction can be avoided without doing violence to the obvious meaning of the language.

Lake Shore Railway Co. *vs.* Car Brake Co., 110 U. S., 229–236.

Reese Button Hole Machine Co, *vs.* Globe Button Hole Co., 61 Fed. Rep., 956.

It has been urged that the invention disclosed by the patent in suit is not of a meritorious character because in the form in which it is there embodied, or at least in the first mechanism manufactured by Westinghouse, it failed of success in some essentials, and was immediately improved by Westinghouse in a manner which was the subject of a subsequent patent, before it was successful in the use for which it was intended. The defect developed by experimental test and which Westinghouse in a few months remedied was that the opening uncovered by the auxiliary valve was not sufficiently large to suddenly release the full volume of train-pipe air. This was not a defect inherent in the device.

59 Fed. Rep., 581–591.

There were structural objections to making that opening large, but when made larger, the device answered the purpose for which it was intended. It was thought, however, better to remedy the difficulty by adding an auxiliary piston as well as an auxiliary valve, and it was in that line that Westinghouse carried his further improvements, and he has adopted that form as the best to be manufactured for general use.
1375 This defect in the patent in suit was not radical and was only one of those defects common in the first forms of many pioneer inventions which usually have to be improved upon before they attain commercial success.

It is further urged that in a doubtful case the scale should be turned by the fact that subsequent to the date of the patent in suit, indeed more than two years after the institution of this suit, patents

Nos. 481,134 and 481,135, August 16, 1892, were granted to Boyden for the mechanism now used by the defendant.

Boyden was entitled to patents for whatever was a patentable novelty in the devices by which he was able to make his valve 22 answer for both service and quick-action work in connection with the restricted passage B, and for any other patentable novelty in the forms of his mechanism. The widely different forms in which he has illustrated his devices in the two above-mentioned patents show that taking what Westinghouse had discovered and demonstrated to be the underlying principle of a quick-action brake, a skillful and inventive mechanic can devise many forms for applying it.

But in his specification of patent No. 481,134 and No. 481,135, Boyden alleges that his device differs essentially from Westinghouse's patent No. 360,070, and involves a new mode of operation. The question whether it does or not was the very question pending in this suit, and so far as the examiner passed upon it in allowing the specification to stand, he did so upon the *ex parte* application of Boyden and unassisted by testimony as to the state of the art at the date of the Westinghouse patent, without testimony as to the scope of the Westinghouse quick-action invention and its great importance and merit; and, therefore, without the opportunity of judging whether or not it was a pioneer invention of a fundamental character entitled to a construction coextensive with the invention, or was simply a patent for an improvement in a known art to be restricted to the form of the device shown in the model and illustrations.

The determination of that question is the starting point in
1376 the consideration of the controversy, and, in my judgment, the
fact that Westinghouse was the first discoverer of the vital underlying invention, should turn the scale in his favor.

The complainants are entitled to a decree for an injunction and account, with a reference to a master in the usual form.

Decree.

Filed April 25, 1895.

United States Circuit Court, District of Maryland.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY
vs.
BOYDEN POWER BRAKE COMPANY; GEORGE A. BOYDEN, President; Charles B. Mann, Secretary; William Whitridge, Treasurer, and Boyden Brake Company.
} In Equity. No. 321.

And now, to wit, this 25th day of April, 1895, the above-entitled cause having come on regularly for hearing, before the Honorable Thomas J. Morris, district judge, holding circuit court, on bill, answer, replication and proofs taken by and on behalf of the respective parties hereto, and having been argued by Mr. George H. Christy

nd Mr. Frederic H. Betts, for complainants, and by Mr. Lysander Hill, Mr. Skipwith Wilmer and Mr. Hector T. Fenton, for defendnts, and the court having considered the same, and being duly dvised in the premises, it is thereupon ordered, adjudged, and decreed:

377 1st. That the letters patent recited in complainants' bill of complaint, to wit, letters patent of the United States, No. 360,070, dated March 29, 1887, and granted to George Westinghouse, Jr., for a new and useful improvement in fluid-pressure automatic brake mechanism, are a good and valid patent in all respects as regards and to the extent of the subject-matter of invention referred to and summed up in the several claims declared upon herein, to wit, claims numbered one, two and four of said recited patent; that George Westinghouse, Jr., was the true, original and first inventor thereof; and that the complainants have a good and sufficient title thereto, and are entitled to the exclusive right therein and thereunder.

2d. That the defendants above named, by the manufacture, use and sale of fluid-pressure automatic brake mechanism, as set forth and shown in and by the proofs herein, and (for greater certainty herein) more particularly as shown and described in certain letters patent of the United States, No. 481,134 and No. 481,135, both dated August 16, 1892, and both granted to The Boyden Brake Company, assignee of George A. Boyden, defendants herein, have infringed the said second claim of said recited patent No. 360,070, and have violated the exclusive right of the complainants therein and thereunder, and that a writ of injunction, conformable to the prayer of said bill, and in the usual form, be issued by the clerk, perpetually enjoining and restraining the said defendants and each of them from any further manufacture, use or sale of the apparatus, mechanism and devices complained of herein, and of and other apparatus, mechanism or devices substantially such in construction and operation as that which is referred to in and constitutes the subject-matter of said second claim, and from doing any act or thing in infringement of said second claim, or in violation of the exclusive right so as aforesaid vested in said complainants therein and thereunder.

3d. That reference be made herein to G. Morris Bond, Esq., as master, to take, state and make return of an account of the gains and profits made by said defendants, as also of the damages suffered by said complainants by or on account of said infringement,
1378 and that the parties appear before the master and produce books and papers and render accounts as he may, from time to time, direct.

4th. That as regards claims one and four of said patent No. 360,070, the court being of the opinion that defendants' device hereinbefore referred to does not infringe the same, injunction is refused and the bill of complaint is, in reference to such claims, hereby dismissed.

5th. And it is further ordered that all questions of the allowance of costs are reserved until the final decree.

THOS. J. MORRIS, *Judge.*

Petition for Appeal; Order Thereon Allowing the Appeal and Assignment of Errors.

Filed April 29, 1895.

United States Circuit Court, District of Maryland.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY
vs.
BOYDEN POWER BRAKE COMPANY; GEORGE A. Boyden, President; Charles B. Mann, Secretary; William Whitridge, Treasurer, and Boyden Brake Company.
In Equity. No. 321.

To the Hon. Thomas J. Morris, judge:

And now, April 29th, 1895, come the defendants into court by Messrs. Barton and Wilmer their solicitors, and pray for allowance of an appeal to the United States circuit court of appeals for
1379 the fourth circuit from the interlocutory decree in said cause
entered the 25th day of April, 1895, awarding an injunction and account as prayed in the bill of complaint in respect of the 2d claim of the letters patent in suit, that a proper citation may be issued and served upon the plaintiffs in said case, or their solicitors, and that a transcript of the record, proceedings and evidence in said case, duly authenticated, may be transmitted to said circuit court of appeals.

BARTON & WILMER,
Sol's for Defendants.

Whereupon it is now ordered this 29th day of April, 1895, that said appeal be and is hereby allowed.

And it is further ordered that security on appeal in the sum of five hundred dollars be entered by the appellants.

THOS. J. MORRIS, *Judge.*

Assignment of Errors.

United States Circuit Court of Appeals, Fourth Circuit.

THE BOYDEN POWER BRAKE COMPANY *et al.*, Appellants and Defendants Below,
vs.
GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE CO., Appellees and Plaintiffs Below.
In Equity.

And now, April 29th, 1895, come the appellants in above case, by their counsel, and say that in the record and proceedings therein there is manifest error in this, to wit:
1380 1st. The circuit court erred in adjudging the 2d claim of the patent in suit to be valid, because it is functional in form

nd therefore legally incapable of interpretation as for a combina-ion of mechanism.

2d. The circuit court erred in its interpretation of the 2d claim f the patent in suit, because said claim being functional in form, hould, if capable of being sustained, have been construed to be or the mechanism described in the specification as essential in the erformance of the function recited in the claim, and hence inclusive f an auxiliary valve actuated by the triple-valve piston on its fur-her or full traverse, and thereby brought into register with an in-lependent port and passage having no connection with the triple-valve mechanism.

3d. The court erred in its interpretation of claim 2 of the patent n suit, in that it held that said claim broadly covered any com-bination of valve mechanism (including a triple valve) in which rain-pipe air was admitted to the brake-cylinder by a further or full traverse of the triple-valve piston.

4th. The circuit court erred in its construction of claim 2, because its adjudged interpretation thereof is based upon the erroneous premise that the "further traverse" of the triple-valve piston was a new and "unusual" motion or function of said device in this com-bination, whereas in truth and in fact said "further traverse" was the usual, old and ordinary function of the piston of the old and well-known triple valve; and whether new or old, usual or unusual, was and is wholly ineffectual to produce the function recited in the plaintiffs' device, without the addition of another and distinct port and passage leading to the brake-cylinder and another and auxil-iary and additional valve governing the same and actuated by the triple-valve piston on its "further" traverse.

5th. The circuit court erred in construing claim 2 as a generic claim, because the plaintiff was estopped by its declarations made in its suit on its later patent No. 376,837, from claiming that the prior patent No. 360,070, in suit was in any sense a pioneer patent.

6th. The circuit court erred in broadly construing claim 2 of the patent in suit as for a combination of mechanism in which
1381 the auxiliary valve or its equivalent, as well as the port and the passage controlled thereby, need not necessarily be sepa-rate and independent of the triple-valve mechanism proper; because there is no warrant in the specification for any such interpretation of the claim.

7th. The circuit court erred in broadly construing claim 2 of the patent in suit as for a combination of mechanism in which the auxiliary valve or its equivalent, as well as the port and the passage controlled thereby, need not necessarily be separate and independent of the triple-valve mechanism proper, because the state of the art disclosed in the record legally precluded any such generic interpre-tation.

8th. The circuit court erred in broadly construing claim 2 of the patent in suit as for a combination of mechanism in which the auxiliary valve or its equivalent, as well as the port and the passage controlled thereby, need not necessarily be separate and independent of the triple-valve mechanism proper; because the declarations of

the patentee contained in the file of the application for the patent required as matter of law a narrower, more restricted and different interpretation.

9th. The circuit court erred in its interpretation of said second claim, because the plaintiffs' alleged invention being admittedly an improvement consisting only in the addition to the old and well-known triple-valve mechanism and without any change whatever in the latter, either in construction or function, of an independent element, arranged in juxtaposition with, so as to be actuated by, such triple-valve piston on its extreme traverse, and whereby such added element produced an additional result exclusively its own, should have been interpreted to be inclusive only of mechanism mechanically equivalent to such new and added part, and not as construed by the court to be inclusive of any mechanism generally capable of performing such new and additional result.

10th. The circuit court erred in adjudging that the defendants' apparatus infringed said second claim, because the defendants' device does not employ an auxiliary valve nor any equivalent super-added element to accomplish the new or additional result
1382 described in the claim, but performs the function and result
recited in the claim by mechanism wholly different therefrom in principle of construction and operation, viz., solely by an ingenious modification of a chamber wall of the triple valve itself and without any additional passageway or port, or auxiliary valve governing such port and passage, or any mechanical equivalent for the same or any of them.

11th. That the circuit court erred in holding that the defendants have infringed the second claim of said patent No. 360,070, whereas, in law, it should have held that the defendants had not infringed said cl.im in view of the finding by the court that defendants poppet valve 22, is not an auxiliary valve.

12th. The circuit court erred in holding said 2d claim to be entitled to cover functional equivalents, whereas it should have held it entitled to cover only the means specified in the patent or their mechanical equivalents.

13th. The court erred in not giving proper weight and force to the disclaimers and limiting statements of the patent in suit, and to the record of proceedings in the Patent Office when said patent was applied for.

14th. The circuit court erred in granting an injunction restraining these defendants from manufacturing, selling and using air-brake apparatus constructed under, and in substantial accordance with, the patents granted to George A. Boyden, dated August 16, 1892, No. 481,134 and No. 481,135.

15th. The court erred in not giving proper weight and force to the statements contained in the patents to George A. Boyden, No. 481,134 and No. 481,135, in which the defendants' device is differentiated from the device of the patent in suit.

16th. The circuit court erred in construing the 2d claim as covering the defendants' device after finding that the poppet valve 22, must be considered to be the main valve of the triple-valve device

and admits the air from the main air pipe to the brake-cylinder, and that the device described in the specification of the patent in suit to perform that function, is a valve independent of, and performs none of the functions of, the main valve of the ordinary triple-valve device.

1383 17th. The court erred in awarding the injunction appealed from.

18th. The circuit court erred in not fully dismissing the bill.

Wherefore, the appellants, The Boyden Power Brake Company, *et al.*, pray that the decree of the circuit court of the United States for the district of Maryland, may be reversed by this honorable court, and that the said circuit court be directed by the mandate of this court to enter a decree rescinding the decree appealed from and directing a dismissal of the bill of complaint filed in said cause, with costs to the appellants and defendants below.

BARTON & WILMER,
Of Counsel for Appellants.

Appeal Bond.

Filed April 29, 1895.

Know all men by these presents, that we, the Boyden Brake Company, as principal, and Douglas H. Thomas, as surety, are held and firmly bound unto George Westinghouse, Jr., and the Westinghouse Air Brake Company, in the full and just sum of five hundred dollars, to be paid to the said George Westinghouse, Jr., and the Westinghouse Air Brake Company, his and their certain attorney, executors, administrators or assigns; to which payment, well and truly to be made, the Boyden Brake Company aforesaid binds itself and its successors or assigns, and the said Douglas H. Thomas binds himself, his heirs, executors and administrators, jointly and severally by these presents.

Sealed with our seals and dated this twenty-ninth day of April, in the year of our Lord one thousand eight hundred and ninety-five.

Whereas, lately at a circuit court of the United States for the district of Maryland, in a suit depending in said court, be-
1384 tween George Westinghouse, Jr., and The Westinghouse Air Brake Company, complainants, and The Boyden Power Brake Company, George A. Boyden, president, Charles B. Mann, secretary, William Whitridge, treasurer, and The Boyden Brake Company, defendants, a decree was rendered against the said defendants, and the said defendants having obtained an appeal to reverse the decree in the aforesaid suit, and a citation directed to the said George Westinghouse, Jr., and The Westinghouse Air Brake Company, citing and admonishing them to be and appear at a United States circuit court of appeals for the fourth circuit, to be holden at Richmond, on the day in the said citation mentioned:

Now, the condition of the above obligation is such, that if the said defendants shall prosecute their appeal to effect and answer all

costs if they fail to make their plea good, then the above obligation to be void; else to remain in full force and virtue.

In testimony whereof, the said Boyden Brake Company hath caused its corporate seal to be hereunto affixed, and George A. Boyden, its president, hath hereunto subscribed his name, and Douglas H. Thomas, the surety above named, hath also subscribed his name and affixed his seal, on the day and year aforesaid.

[Seal of the Boyden Brake Co.]

GEO. A. BOYDEN, *Pst.*
DOUGLAS H. THOMAS. [SEAL.]

Signed, sealed and delivered in presence of—
L. J. VAN HORN.

Approved by—
THOS. J. MORRIS, *Judge.*

1385 *Citation.*

UNITED STATES OF AMERICA, *ss:*

The President of the United States to George Westinghouse, Jr., and The Westinghouse Air Brake Company, Greeting:

You are hereby cited and admonished to be and appear at a United States circuit court of appeals for the fourth circuit, to be holden at Richmond on the 25th day of May next, pursuant to an appeal from a decree of the circuit court of the United States for the district of Maryland in your favor, passed in a cause in said court wherein The Boyden Power, Brake Company, George A. Boyden, president, Charles B. Mann, secretary, William Whitridge, treasurer, and Boyden Brake Company, are defendants, and you are complainants, to show cause, if any there be, why the decree rendered against the said defendants in said cause mentioned, should not be corrected, and why speedy justice should not be done to the parties in that behalf.

[COURT SEAL.] Witness, the Honorable Thomas J. Morris, judge of the said circuit court of the United States, this twenty-ninth day of April, in the year of our Lord one thousand eight hundred and ninety-five.

THOS. J. MORRIS, *Judge.*

Test: JAMES W. CHEW,
Clerk U. S. Circuit Court, District of Maryland.

Endorsed.

Due service of the within citation acknowledged, this 29th day of April, 1895.

BERNARD CARTER,
Solicitor for George Westinghouse, Jr., and The Westinghouse Air Brake Company.

1386 *Order Permitting Withdrawal of Exhibits for Use in the United States Circuit Court of Appeals.*

Filed April 30, 1895.

United States Circuit Court, District of Maryland.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY *vs.* BOYDEN POWER BRAKE COMPANY; GEORGE A. Boyden, President; Charles B. Mann, Secretary; William Whitridge, Treasurer, and Boyden Brake Company.	In Equity. No. 321.

Ordered by the court, this 30th day of April, 1895, that the defendants have leave to withdraw the following exhibits from the files of the court in order that they may be exhibited to the United States circuit court of appeals for the fourth circuit on the hearing of said cause on appeal.

Complainants' Exhibit, Defendants' 1891 Catalogue.

Complainants' Exhibit, Defendants' 1889 Catalogue.

Complainants' Exhibit Drawing Quick-action Automatic Freight Brake.

Defendants' Exhibit, Westinghouse 1890 Instruction Book.

Defendants' Exhibit, Westinghouse 1886 Instruction Book.

Also such other of the original exhibits as counsel may desire to exhibit to said circuit court of appeals.

It is further ordered that before taking out said exhibits, a receipt shall be given to the clerk of the court for the return of the same after the hearing.

THOS. J. MORRIS, *Judge.*

1387 Thereupon it is ordered by the court here, that a transcript of the record and proceedings in the cause aforesaid, together with all things thereunto relating, be transmitted to the said United States circuit court of appeals for the fourth circuit, and the same is transmitted accordingly.

Test:

JAS. W. CHEW, *Clerk.*

UNITED STATES OF AMERICA, } *To wit:*
District of Maryland, }

I, James W. Chew, clerk of the circuit court of the United States for the fourth circuit in and for the district of Maryland, do hereby certify that the foregoing is a true transcript of the record and proceedings, together with all things thereunto relating, in the therein-entitled cause.

[COURT SEAL.] In testimony whereof, I hereunto set my hand and affix the seal of the said circuit court, this sixth day of May, A. D. 1895.

JAS. W. CHEW,
Clerk of said Court.

1388 *Transcript of Cross-appeal.*

United States Circuit Court of Appeals, Fourth Circuit.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY, Complainants and Appellants,
versus
BOYDEN POWER BRAKE COMPANY; GEORGE A. BOYDEN, President; Charles B Mann, Secretary; William Whitridge, Treasurer, and Boyden Brake Company, Defendants and Appellees. } No. —.

Cross-appeal of the complainants from the decree of the circuit court of the United States for the district of Maryland.

Record filed May 14, 1895.

1389 *Transcript of Cross-appeal.*

United States Circuit Court of Appeals, Fourth Circuit.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY, Complainants and Appellants,
versus
BOYDEN POWER BRAKE COMPANY; GEORGE A. BOYDEN, President; Charles B. Mann, Secretary; William Whitridge, Treasurer, and Boyden Brake Company, Defendants and Appellees. } No. —.

Cross-appeal of the complainants from the decree of the circuit court of the United States for the district of Maryland.

1390 UNITED STATES OF AMERICA, *District of Maryland,* } *To wit:*

At a circuit court of the United States for the fourth circuit, in and for the district of Maryland, begun and held at the court-house in the city of Baltimore on the first Monday of April, being the first day of the same month in the year of our Lord one thousand eight hundred and nine y-five—

Present: The Honorable Thomas J. Morris, judge of the Maryland district; William L. Marbury, Esq., attorney; Charles H. Evans, Esq., marshal; James W. Chew, clerk—

Among other were the following proceedings, to wit:

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY, Complainants,
vs.
BOYDEN POWER BRAKE COMPANY; GEORGE A. BOYDEN, President; Charles B. Mann, Secretary; William Whitridge, Treasurer, and Boyden Brake Company, Defendants.
} In Equity.

1391 *Petition of Complainants for an Appeal, Order of Court Allowing the Appeal, and Assignment of Errors.*

In the Circuit Court of the United States, District of Maryland.

GEORGE WESTINGHOUSE, JR., and THE Westinghouse Air Brake Company, Complainants and Appellants,
v.
BOYDEN POWER BRAKE COMPANY; GEORGE A. Boyden, President; Charles B. Mann, Secretary; William Whitridge, Treasurer, and Boyden Brake Company, Defendants and Appellees.
} In Equity. No. 321.

The above-named complainants, George Westinghouse, Jr., and The Westinghouse Air Brake Company, conceiving themselves aggrieved by so much of the interlocutory decree heretofore entered in said cause, as relates to claims one and four of the patent in suit, No. 360,070, do hereby appeal to the United States circuit court of appeals for the fourth circuit from so much and such parts of said decree as refuse an injunction under the claims numbered one and four of the patent in suit, No. 360,070, or as contain or involve a refusal of an injunction under said claims, and they pray that this, their appeal, may be allowed, and that a transcript, duly
1392 authenticated of the record and proceedings in the above-entitled cause, upon which so much of said decree was made, may be transmitted with said appeal to the circuit court of appeals for the fourth circuit, or if it be that such a transcript has already been transmitted to the circuit court of appeals on the appeal of the original defendants herein, then they pray that this, their appeal, being a cross-appeal, may be allowed, and that a certified transcript of so much of the record and proceedings herein as appertain to the subject-matter of this appeal, and as have not already been certified in said original appeal, as aforesaid, may be transmitted with this appeal to the circuit court of appeals for the fourth circuit.

BERNARD CARTER,
Solicitor for Complainants.

Ordered, this 13th day of May, 1895, that the above appeal be allowed as prayed for, and the clerk will certify accordingly; provided, the appellant- shall refund to the appellees or to the clerk the one-half of the cost of the transcript already transmitted.

THOS. J. MORRIS, *Judge.*

And *eo die* come the complainants in the above-entitled cause and file, with their foregoing petition for appeal, these their assignments of error:

1st. That the court erred in finding that defendants' apparatus did not contain an auxiliary valve within the meaning of claims one and four of patent No. 360,070, and of each of them.

2d. That the court erred in holding that it is an essential
1393 feature of the auxiliary valve of the patent in suit that it "performs none of the functions of the main valve of the ordinary triple-valve device."

3d. That the court erred in finding that the quick action or emergency valve 22 of defendants' apparatus is in any practical or operative or commercial sense a main valve, or that in practical use it has the capacity or does the work of a main valve, or that to any practical or material extent it "performs the functions of a main valve of the triple valve."

4th. That the court erred in holding that the valve *i j k* of defendants' apparatus is not a main valve within the meaning of claims one and four of patent 360,070 and of each or either of said claims.

5th. That the court erred in holding that the defendants' apparatus did not contain the invention of claims one and four and of each of them.

6th. That the court erred in not holding that in defendants' apparatus, and for the purposes of this case, the valve *i j k* is or represents the valvular appliance by or through which the ordinary service work of the brake is done, and valve 22 is or represents the valvular appliance by or through which quick action or emergency work is done, and also in not holding that such use and operation of defendants' apparatus involves an unauthorized use of the invention of claims one and four of patent 360,070, and is an infringement thereof.

7th. That the court erred in refusing and in not granting an injunction under each and both of said claims.

Wherefore, these appellants, George Westinghouse, Jr., and The Westinghouse Air Brake Company, pray that the decree of the circuit court of the United States for the district of Maryland may be reversed by this honorable court in respect of the matters
1394 herein appealed, and that the said circuit court be directed by the mandate of this court to enter a decree for an injunction and account under claims one and four of the patent in suit, No. 360,070, with costs to the appellants herein and complainants below.

BERNARD CARTER,
Solicitor for Appellants.

Service of copy of the within admitted this 13th day of May, 1895.

BARTON & WILMER,
Solicitors for Defendant-.

Complainants' Appeal Bond.

Filed May 13th, 1895.

Know all men by these presents that we, George Westinghouse, Jr., and the Westinghouse Air Brake Company, as principals, and W. J. C. Dulany, of Baltimore, Maryland, as surety, are indebted to Boyden Power Brake Company, George A. Boyden, president; Charles B. Mann, secretary; William Whitridge, treasurer; and Boyden Brake Company, in the penal sum of five hundred dollars, good and lawful money of the United States, for the payment of which, well and truly to be made, we do bind ourselves, our successors, heirs, executors and administrators jointly and severally by these presents.

In testimony whereof, the said obligors above named have hereunto affixed their respective hands and seals this 13th day of May, A. D. 1895.

The condition of the above obligation is such that, whereas, in the cause now pending in the circuit court of the United States in and for the district of Maryland, wherein the said George Westinghouse, Jr., and The Westinghouse Air Brake Company are
1395 complainants, and the said Boyden Power Brake Company, George A. Boyden, president, Charles B. Mann, secretary; William Whitridge, treasurer; and Boyden Brake Company, are defendants, a decree was entered on the 25th day of April, A. D. 1895, by the Hon. Thomas J. Morris, judge of the said court, against the said Boyden Power Brake Company, George A. Boyden, president; Charles B. Mann, secretary; William Whitridge, treasurer; and Boyden Brake Company, defendants, in favor of the said George Westinghouse, Jr., and The Westinghouse Air Brake Company, complainants, among other things, enjoining the said defendants as therein set forth; and, whereas, the said George Westinghouse, Jr., and the Westinghouse Air Brake Company have prayed an appeal from said decree to the United States circuit court of appeals for the said circuit, which said appeal has been allowed.

Now, therefore, if the said George Westinghouse, Jr., and the Westinghouse Air Brake Company shall well and duly prosecute the said appeal with effect, and shall answer to the said Boyden Power Brake Company, George A. Boyden, president; Charles B. Mann, secretary; William Whitridge, treasurer, and Boyden Brake Company all costs by the said Boyden Power Brake Company, George A. Boyden, president; Charles B. Mann, secretary; William Whitridge, treasurer, and Boyden Brake Company sustained, in case they, the said George Westinghouse, Jr., and the Westinghouse Air Brake Company shall fail to sustain their said appeal, then, and in such case, the above obligation is to be void, otherwise to be, and remain, in full force and effect.

GEO. WESTINGHOUSE, JR. [L. S.]

[Seal of Westinghouse Air Brake Company.]

THE WESTINGHOUSE AIR BRAKE CO.,
By H. H. WESTINGHOUSE, *General Manager.*
WM. J. C. DULANY. [L. S.]

1396 STATE OF PENNSYLVANIA, } ss:
County of Allegheny,

Before me, the undersigned authority, hereunto duly authoriz
personally appeared George Westinghouse, Jr., and H. H. Westin
house, general manager of the Westinghouse Air Brake Compan
obligors above named, who acknowledged the foregoing signatur
as their voluntary act, for the purposes and uses therein set fortl
Witness my hand and official seal this ninth day of May, A.
1895.

[SEAL OF NOTARY.] F. E. GARTHER,
Notary Public.

STATE OF MARYLAND, } ss:
City of Baltimore,

Before me, the undersigned authority, hereunto duly authoriz
personally appeared W. J. C. Dulany, obligor above named, w
acknowledged the foregoing signature as his voluntary act for t
purposes and uses therein set forth.
Witness my hand and official seal this 13th day of May, A.
1895.

[SEAL OF NOTARY.] MURRAY HANSON,
Notary Public.

And now, to wit, May 13th, 1895, the within bond presented, a
proved and ordered to be filed.

THOS. J. MORRIS, *Judge.*

1397 *Citation.*

UNITED STATES OF AMERICA, } ss:
District of Maryland,

To the Boyden Power Brake Company; George A. Boyden, pre
dent; Charles B. Mann, secretary; William Whitridge, treasur
and Boyden Brake Company:

You are hereby cited and admonished to be and appear at a te
of the circuit court of appeals of the United States in and for t
fourth circuit, to be holden in the city of Richmond, State of V
ginia, at the term of said court, on the 28th day of May, A.
1895; pursuant to an appeal filed in the clerk's office of the circ
court of the United States, wherein George Westinghouse, Jr., a
The Westinghouse Air Brake Company are appellants, and you a
the appellees, and show cause, if any there be, why the decree
said appeal mentioned should not be reversed or corrected, as
gards so much and such parts of the said decree as contain or i
volve the refusal of an injunction under claims 1 and 4 of the p
ent in suit No. 360,070, as referred to in the bill of complaint there
and speedy justice not be done to the parties in that behalf.
Witness, the Honorable Thomas J. Morris, judge of the sa

circuit court of the United States, this 13th day of May, in the year of our Lord one thousand eight hundred and ninety-five.

[The Seal of the Circuit Court, Maryland.]

THOS. J. MORRIS, *Judge.*

Service of the within citation acknowledged this 13th day of May, 1895.

BARTON & WELMER,
Solicitors for Defendant-.

1398 Thereupon, it is ordered by the court here that a transcript of the cross-appeal of the complainants in the cause aforesaid, together with all things thereunto relating, be transmitted to the said United States circuit court of appeals for the fourth circuit, and the same is transmitted accordingly.

Test: JAS. W. CHEW, *Clerk.*

UNITED STATES OF AMERICA, *District of Maryland*, } *To wit:*

I, James W. Chew, clerk of the circuit court of the United States for the fourth circuit, in and for the district of Maryland, do hereby certify that the foregoing is a true transcript of the cross-appeal of the complainants, together with all things thereunto relating in the therein-entitled cause.

Seal of the Court. In testimony whereof, I hereunto set my hand and affix the seal of the said circuit court this 13th day of May, A. D. 1895.

JAS. W. CHEW,
Clerk of said Circuit Court.

1399 *Proceedings in the United States Circuit Court of Appeals, Fourth Circuit.*

United States Circuit Court of Appeals, Fourth Circuit.

BOYDEN POWER BRAKE COMPANY *et al.*, Appellants, *vs.* WESTINGHOUSE AIR BRAKE COMPANY *et al.*, Appellees. } No. 131. Appeal from the Circuit Court of the United States for the District of Maryland.

WESTINGHOUSE AIR BRAKE COMPANY *et al.*, Appellants, *vs.* BOYDEN POWER BRAKE COMPANY *et al.*, Appellees. } No. 134. Cross-appeal from the Circuit Court of the United States for the District of Maryland.

April 17, 1895, petition of appellant- in No. 131, affidavit, and order of court thereon relating to filing printed records, was filed, to wit:

Petition, Affidavit, and Order of Court Relative to Filing Printed Records.

Filed April 17, 1895.

In the United States Circuit Court, District of Maryland.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY *vs.* BOYDEN POWER BRAKE COMPANY; G. A. BOYDEN, President; C. B. Mann, Secretary; William Whitridge, Treasurer.	In Equity.

To the honorable judges of the U. S. circuit court of appeals, fourth circuit:

In the above-entitled cause a decision was rendered on the
1400 11th day of March by U. S. circuit court, district of Maryland, in favor of the complainants, and, from which decision defendants have appealed.

Under rule 23 of the U. S. circuit court of appeals, the appellant is required to furnish the court with twenty copies of the complete printed record "unless a different order as to such printing is made by the court of its own motion or upon application."

The court is therefore petitioned for an order permitting the defendants—appellants on appeal—to file four copies of the complete printed record with the court. This number will provide each of the three judges with a copy and an additional one in case it is required. The complainants—appellees on appeal—will also be furnished with three copies as required by rule 23.

It if exceedingly important to the defendants that the appeal be heard in the May term, as an injunction has been granted restraining them from manufacturing the device in controversy.

It is impossible to reprint the complainants' record in time for the case to be heard in the May term, as their record consists of over 700 pages, and is extensively illustrated; to do so will require a great deal of time and labor and involve an expenditure of over one thousand dollars ($1,000).

As the defendants—appellants on appeal—have eight copies of the complainants' record on hand, the record can be made up in time for the May term if the court will grant the desired order. A copy of the order is herewith enclosed.

And as in duty, &c.

SKIPWITH WILMER,
Of Counsel for Appellees.

UNITED STATES OF AMERICA, *District of Maryland*, } *To wit:*

Before the subscriber, a commissioner of the United States, in and for the district of Maryland, personally appeared in the said district

his 13th day of April, in the year eighteen hundred and ninety-five, ieorge A. Boyden, president of the Boyden Brake Company of 3altimore City, and made oath on the Holy Evangely of Almighty iod that the matters and things stated in the foregoing petition are s therein set forth, to the best of his knowledge, information and oelief, and subscribed the same.

G. A. BOYDEN.

[SEAL.] GEORGE MORRIS BOND,
United States Commissioner for the
District of Maryland.

1401 Ordered by this court this 17th day of April in the year eighteen hundred and ninety-five, on the foregoing petition and affidavit that the appellants be, and they are hereby permitted and authorized to file with the clerk four copies of the record for the use of the court and three for the use of counsel for the appellees, instead of twenty copies as required by rule 23, as prayed in the said petition.

N. GOFF.

May 7, 1895, the transcript of the record in No. 131 and six copies of the printed record was filed, and appearances of Skipwith Wilmer, Hector T. Fenton, and Lysander Hill were entered for the appellants.

May 9, 1895, appearances of Bernard Carter, J. Snowden Bell, and George H. Christy were entered for the appellees in No. 131.

May 14, 1895, the transcript of the record on cross-appeal (No. 134) was filed, and appearances of J. Snowden Bell, George H. Christy, and Bernard Carter were entered for the appellants.

May 16, 1895, appearances of Barton & Wilmer, Lysander Hill, and Hector T. Fenton were entered for the appellees in No. 134.

May 16, 1895, 16 copies of the printed record, together with the following petition of the appellants, were filed in No. 134.

Petition to file printed records on cross-appeal *nunc pro tunc* as of May 7, 1895.

Motion to File Record on Cross-appeal Nunc pro Tunc.

Filed May 16, 1895.

U. S. Circuit Court of Appeals, Fourth Circuit.

GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY
vs.
BOYDEN POWER BRAKE CO., GEORGE A. BOYDEN, Charles B. Mann, William Whitridge, and Boyden Brake Co.
} In Equity. No. 134.

And now, to wit, May 16th, 1895, the complainants above named file this their motion that the printed records of their cross-
1402 appeal, filed herewith, may be ordered to be filed *nunc pro tunc*, as of May 7th, 1895,—to the end that both appeals may

come on together regularly for hearing under the rules—this motion being based on the following, among other facts:

1st. Decree was not entered till April 25th, 1895.

2nd. Original appeal was not taken until April 29th, 1895.

3rd. Complainants' counsel were not advised of any intention that the hearing thereof would be urged for the coming term, until they were served with the printed records, the latter though served formally on May 8th, not reaching them until May 10th.

4th. During the week next following the original appeal, complainants' counsel were necessarily engaged in preparing and arguing in the U. S. circuit court of appeals for the second circuit the appeal taken by the defendants from the decree of Judge Lacombe granting an injunction in Westinghouse *et al.* v. New York Air Brake Company *et al.* for infringement, *inter alia*, of the patent here in suit.

For these reasons, the delay was unavoidable, and this motion is made accordingly.

GEORGE H. CHRISTY,
For Complainants.

June 8, 1895, motion of appellees in open court in No. 134 to dismiss the cross-appeal.

June 10, 1895, motion of appellees in No. 134 to dismiss the cross-appeal was argued, and the motion was denied.

June 10, 1895 (May term, 1895), both causes came on to be heard on the transcripts of the record from the circuit court of the United States for the district of Maryland, and were argued together by counsel, and submitted.

At the November term, 1895, to wit: November 11, 1895, the court announced and filed its opinion, which is as follows, to wit:

403 *Opinion.*

United States Circuit Court of Appeals, Fourth Circuit.

BOYDEN POWER BRAKE COMPANY *et al.*, Appellants, *vs.* WESTINGHOUSE AIR BRAKE COMPANY *et al.*, Appellees.	No. 131. Appeal from the Circuit Court of the United States for the District of Maryland.
WESTINGHOUSE AIR BRAKE COMPANY *et al.*, Appellants, *vs.* BOYDEN POWER BRAKE COMPANY *et al.*, Appellees.	No. 134. Cross-appeal from the Circuit Court of the United States for the District of Maryland.

(Causes argued together June 10, 1895. Decided November 11, 1895.)

Before Goff and Simonton, circuit judges, and Hughes, district judge.

Lysander Hill, Hector T. Fenton, for the Boyden Power Brake Company, Skipwith Wilmer on the brief; George H. Christy, Frederick H. Betts, for Westinghouse Air Brake Company, J. Snowden Bell and Bernard Carter & Son on the brief.

Statement.

George Westinghouse, Jr., one of the complainants in this suit, is the inventor of automatic air brakes for the slowing and stopping of railroad trains. He has taken out patents for devices in this connection to the number of some ten or twelve. Of these, the patent now in suit is that numbered 360,070, issued March 29, 1887.

This device does not seem to have proved effectual for the
1404 special purposes for which it was designed, and he improved
it by a later one, patented to him on January 24, 1888, numbered 376,837, which is not in suit. These two devices, while preserving the mechanism for the ordinary stopping of trains embraced in earlier patents, contained additional mechanism for their prompt and complete stoppage in sudden emergencies. The apparatus as thus devised and improved are technically called quick-action brakes, and are embraced in the patents 360,070 and 376,837.

Of the air brakes patented by Westinghouse previously to the issuing of the two patents just named, the latest improvements were embraced in the patent numbered 220,556, issued October 14, 1879. In speaking of this latter patent we shall, except when special mention of previous ones will be necessary, include generically all the improvements embodied severally in its predecessors. This air brake 220,556, though intended for both ordinary work and emer-

gency work, proved to be really effective only for the ordinary slowing and stopping of trains, and not to answer for the sudden stoppage of very long trains of cars. But it contained the auxiliary reservoirs and other apparatus which gave the brakes an automatic action. These three patents, numbers 220,556, 360,070 and 376,837, are those which enter most directly into the consideration of the case before us.

It is true that the patent of Westinghouse, number 168,359, is mentioned in complainants' bill of complaint, and not number 220,556; but in the briefs and in most of the testimony number 220,556 is made the prominent subject of discussion, and not number 168,359. There was an intermediate patent, number 217,838, which enters more or less into the polemics of this controversy; inasmuch as that patent, as well as number 220,556, already mentioned, were the immediate bases on which the quick-action brake, number 360,070 was founded.

In the earlier stages of the development of the Westinghouse air brake, it consisted of the following parts: First, a compressing air pump on the engine by which air was compressed to the density of eighty pounds to the square inch; second, a large reservoir for storing the compressed air fixed on the engine; third, a train-pipe or main pipe leading from the engine to and along all the cars of the train, connected at each interval between the cars by a flexable hose with couplings rendering the train-pipe continuous and constituting it a conduit for transmitting compressed air from the engine to every car; and fourth, a brake-cylinder on each car, connected by a branch pipe to the train-pipe, and chargeable with
1405 compressed air through the train-pipe from the storage reservoir on the engine—this brake-cylinder operating, by means of suitable levers, upon the brake-shoes which clasped the wheels of each car.

Useful as this system of braking proved to be, it was found not to meet all the requirements of the service. In the transmission of compressed air from the engine an appreciable loss of time was found to occur. This loss proved to be about one second per car; so that on a passenger train of ten cars the time necessary for the pressure to reach the rear car would be ten seconds; and on a freight train of fifty cars would be nearly a minute. Thus, while the forward movement of the foremost cars would be checked at once, that of the rearmost cars would not be as promptly checked, and these would come against the cars in front of them with more or less shock, producing more or less discomfort or positive damage. This defect will be appreciated when it is remembered that a train moving at the rate of forty-five miles an hour moves sixty-six feet per second; so that, a freight train of fifty cars would run more than half a mile before the brakes could begin to be effective along the entire train. This defective system contained but one reservoir for holding the compressed air, which, as before stated, was attached to the engine, and from which all the brake-cylinders of the several cars had to be charged back through the train-pipe and its branches and couplings.

It was incumbent upon the inventor, therefore, to devise a remedy for this defect in the earliest forms of his air brakes. He supplied it by providing an auxiliary reservoir for compressed air on each car; and also by devising a mechanism for discharging compressed air from this auxiliary reservoir into the brake-cylinder of its own car; so that as soon as the engineer put in action his mechanism for checking or stopping the train, there was a more nearly simultaneous action of the brake-cylinders along the whole train upon the series of brakes provided for each car.

The mechanism devised for this purpose was what is known in the art as the triple valve; one of which was provided for each car, and acted upon each brake-cylinder with compressed air drawn from each auxiliary reservoir. It was called a triple valve because one of its valves controlled the passage between the train-pipe leading from the engine and the auxiliary reservoir; another between the auxiliary reservoir and brake-cylinder belonging to each car, and a third between the brake-cylinder of each car and the atmosphere. It was located at the junction of the three pipes which lead from and to each of these devices. The triple valve has three ports leading, respectively, to the three devices named, and also a fourth one leading to the open air.

1406 A very important feature of the Westinghouse triple-valve mechanism consisted in its being automatic in operation. It is not in our province to enter into details, suffice it to say that when the train is in use all the apparatus which has been described is kept constantly charged in full with compressed air generally to the density of seventy pounds to the inch, which has continuous and unobstructed flow from the main reservoir on the engine to all the auxiliary reservoirs on the cars. While the apparatus is thus full charged from the engine, through the train-pipe to the auxiliary reservoirs, the piston of each triple valve is held to its normal position with the port between the auxiliary reservoir and brake-cylinder closed, there being an equipoise of pressure on each side of it. It follows that whenever the pressure of the air on the train-pipe side of the piston is reduced, the piston moves out into its chamber and thereby opens a passage for the compressed air from each auxiliary reservoir into each brake-cylinder, resulting automatically in an application of the brakes. This reduction of pressure in the train-pipe has the result described, whether it is caused by the engineer in intentionally opening his valve for the purpose, or by an accident which may produce a rupture in any part of the train-pipe. Such action of the engineer, or such accident, opens the train-pipe for the escape of pressure from that side of each triple-valve piston, causes the piston to move forward in its chamber, and thereby to open a passage for discharging compressed air from the auxiliary reservoir to the brake cylinder for action upon the brakes. This *automatic* action was a very important achievement, and gave to the air brake of Westinghouse a part of its name.

Before this invent-on the brake-cylinders were charged directly from the engine by forcing the compressed air backward into them, along the entire length of the train. In the triple-valve device the

air movement was reversed. While the train is running, all the apparatus, except the brake-cylinders, is full of air of the density of seventy pounds, stored distributively in the several auxiliary reservoirs. The engineer operates by opening his valve on the engine for the escape of train-pipe air, which thereby takes a course the reverse of the former, from the rearmost car and moving forward along all the cars to its escape at the engineers' valve.

Thus before the invention of the improved device patented in No. 217,838, when the engineer desired to apply his brakes with full force, he operated the valve at the engine and opened the port wide, letting the compressed air out of the train-pipe at the
1407 locomotive, then its only vent. The air, as before said, had to travel from the rear car along all the cars, forward to the engine, before it could lessen the pressure of the train-pipe air on the train-pipe side of the chamber of each triple-valve piston, and before the brake-cylinders could be operated with air from the auxiliary reservoirs. In a train of fifty cars it would have to travel nearly half a mile to get out at the engine. Westinghouse devised in patent 217,838 a means of quickly emptying the train-pipe by providing release valves on each car connected directly with the train-pipe; so that the air of the train-pipe could be vented promptly at each car, and thus shorten the time of bringing all the brakes along the whole train into action.

But while the triple valve and other mechanism patented in number 217,838 and number 220,556 was intended to accomplish the purpose of producing simultaneous action by the brakes in every car, and thus to prevent, in a great measure, the jostling of cars against each other, thereby securing a comparatively steady, smooth, uniform arrest of movement along the whole train; yet it was found to be effective for this purpose in very long freight trains only on ordinary occasions, such as the stopping of trains at stations, or slowing them at side tracks, or holding their speed in check on descending grades. The mechanism of the patents just named did not provide effectively for sudden emergencies, and therefore failed to meet a great necessity of the service.

It is true that the design of the inventor was to devise in these patents an apparatus that would be effective for both the gradual and the sudden stoppage of trains. For the former purpose he inserted a sens*a*tive valve on the stem of the triple-valve piston of 220,556 by which, on a partial movement of the piston in its chamber, a graduated discharge of air from the auxiliary reservoir into the brake-cylinder was effected. For the latter purpose, the sudden stoppage of trains, he provided a main valve at the end of the stem of the piston by which, on a complete traverse by the triple-valve piston in its chamber, a large venting of compressed air from the auxiliary reservoir was effected, so that, in the language of one of the Westinghouse witnesses, "if an emergency arises demanding that the brakes be instantly applied with full force to effect a sudden stoppage of the train, the pressure of air is suddenly and considerably or entirely reduced in the train-pipe with the result that the piston of the triple valve makes its full stroke, * * * per-

mitting auxiliary reservoir air to flow directly into the brake-cylinder, * * * (making what is known as) the emergency stop."

1408 The inventor, however, failed in this latter object. It was found in practice on long trains that the air from the auxiliary reservoir did not act with sufficient promptitude on the brakes of the rear cars for emergency purposes, and that it would be necessary to devise some other means for effecting a quick action of the brake-cylinder. Patent 168,359, repeated in patent 220,556, was a most valuable invention. It had great utility. It produced a uniform stoppage of the cars of long trains on ordinary occasions, and on short trains, whether passenger or freight, it was practically effective even for emergency purposes. Yet for the sudden stoppage of long trains in the face of immediate danger it failed to answer the requirements of the service. As one of the counsel of Westinghouse expressed it in his oral argument before this court: "A passenger train or a freight train of moderate length, and, therefore, of moderate weight, could be stopped, as is shown by the proofs, by the old automatic brake (patent 220,556) within reasonable limits of distance of space and lapse of time; but the railroad conditions of the country and the system of traffic altering, by which large locomotives drawing heavy and long trains came into use, a new development in the art was called for; that is, for a brake which would act quicker on any car, and act quicker from car to car, than any which had previously existed."

With this brake of patent 220,556, gradual stopping and slowing was executed by giving the piston a partial or half traverse on its chamber by which air passed through the sensitive valve on the stem of the piston to the brake-cylinder; and emergency stopping was done by a full or extreme traverse of the piston in its chamber which closed the sensitive valve in its stem and opened the main valve fixed upon the end of the stem, and allowed a full and direct venting of air from the auxiliary reservoir into the brake-cylinder. The best illustrations available for the better understanding of the preceding remarks are the diagrams that are found opposite pages 20 and 21 of the main brief of the appellants. (Boyden.)

It is obvious from what has been said that the piston of the triple valves is a most prominent instrumentality in the present controversy. The brakes are operated by the engineer from the engine. The engineer's duty in connection with them is, first, to keep his apparatus full charged with compressed air whenever the train is in use, and, second, when the occasion requires, to let off air from the train-pipe, and thereby cause, in the manner heretofore described, the escape of more or less air from the auxiliary reservoirs into the brake-cylinders for action upon the brakes. The

1409 mechanism is such, also, as before stated, that an escape of compressed air from the train-pipe results not merely from the intentional action of the engineer himself, but automatically from any accident that may happen to cause a severance of the train into parts, or a rupture of the train-pipe or its connecting hose or branches. It is the escape or venting of compressed air,

either intentional or accidental, from the auxiliary reservoirs in which it is stored, into the brake-cylinders, that operates the brakes and this venting is done through the triple valves by means, as heretofore stated, of the triple-valve pistons.

In the Westinghouse automatic air brake, as patented in number 220,556, the ordinary work of braking was performed by a partia traverse of its chamber by triple-valve piston, graduated, according to the purpose desired, at the will of the engineer; and emergency work was done by an extreme traverse of the piston to the end o its chamber. It may be observed that the automatic air brake patented as number 220,556, which embraced all previous improve ments, is now free to public use, the patent having expired and ceased to be confined to the exclusive use of its inventor.

A study of patent 220,556 will show that compressed air driven by the engineer into the train-pipe, passed through the triple valve of each car to its auxiliary reservoir; that there was no vent for this train-pipe air into the brake-cylinder, except through the auxiliary reservoir, and that this vent from the auxiliary reservoir to the brake-cylinder ordinarily occurred when the triple-valve piston had made but a partial movement or traverse in its chamber The text and diagram of 220,556 show that even a full or extreme traverse of the piston in its chamber would vent no other compressed air into the brake-cylinders, except from the auxiliary reservoirs.

The device embraced in patent 220.556, valuable and efficient as it is and was for ordinary work on all trains, with the triple-valve piston in partial traverse, and for emergency work on short trains with the triple-valve piston in extreme traverse; yet it failed to meet the requirements of the service for emergency work on long trains of fifty large freight cars. For the latter work it was found insufficient in practice, the insufficiency consisting in not acting with sufficient promptitude. It is not for us to explain why the passage of compressed air exclusively from the auxiliary reservoirs to the brake-cylinders was not sufficiently prompt on long freigh trains. It is assumed in the briefs and testimony that the mechan ism of this patent did not suffice for this work. It is ad
1410 mitted on both sides that while the mechanism of 220,556 though effective for the ordinary purposes of braking trains such as stopping them at stations, slowing them in passing switche and other points requiring continuous movement, and checking them on descending grades, yet that it was not effective for abruptly stopping long trains in sudden emergencies.

This deficiency of the Westinghouse brake in the stage of im provement which it had reached in patent 220,556, from whateve cause resulting, created the necessity for some additional invention by which, on sudden emergencies in the presence of immediate danger, a long train of cars in rapid motion should be immediately brought to an abrupt stoppage by an instantaneous and simultane ous application of all the brakes of every car. The thing wanted was what has technically come to be called "quick action."

Each of the chief contestants in the present suit set himself laud ably to work in deriving a means to accomplish this importan

desideratum, each taking the air brake, patented as number 220,556, Westinghouse's exclusive property in which has expired, as the basis of his new device, the common object being to produce a mechanism by which to secure instantaneously, whenever and only when a sudden emergency arose, such a quickened discharge of compressed air into the several brake-cylinders that each car would simultaneously, and the entire train as a whole, be brought to a sudden hault, but leaving all the mechanism already existing for use in ordinary braking unmolested and unchanged.

Counsel for appellees (Westinghouse) in his oral argument well described the need that was to be supplied when he said: "Quick action does not involve greater *power* of the brake; it is not a question of greater force of brake, as applied to the brake-shoes of any individual car. The force with which the brak'-shoes are applied to any individual car is no greater with the Westinghouse quick-action brake (360,070), which is in controversy here, than it was with the old automatic brake (220,556). The engineer is, in both cases, operating with seventy pounds of pressure in the main reservoir on the locomotive and in the auxiliary reservoirs on the cars throughout the train, and in the system of pipes throughout the train, and all the force he can possibly apply with the present quick-action brake (360,070), or with the old automatic brake (220,556), is seventy pounds of pressure to the piston of the brake-cylinder, and through it to the brake-shoes."

And the same counsel well described the desideratum sought for—the gist of the urgent need—when he said that its char-
1411 acteristic must be "the utilization of auxiliary reservoir pressure for service or for graduation, when you do not need to use quick action; but when you want to get what is known in the art as *quick*-action, when the question of life or death is to be settled in a few seconds, then the pressure from the *train-pipe*, (which comes from the main reservoir on the locomotive,) is to be utilized for that purpose."

Westinghouse devised for each car an additional valve, which he so attached to the triple valve of patent 220,556 that when the piston should be in complete traverse and driven to the end of its chamber, it should drive forward an additional stem provided for this additional valve, and thereby open a port in that valve by which compressed air from the train-pipe should pass, through by-passages independent of the triple valve, into the brake-cylinder into which the triple valve vented compressed air from the auxiliary reservoir. By this device of the additional stem, the additional valve and the independent by-passages into which the latter opened, the inventor contrived to discharge compressed air from both the auxiliary reservoir and the train-pipe into the brake-cylinder of each car simultaneously, and thereby so quickened the action of the brakes as to accomplish the desideratum of *quick action.* To repeat, his device for this purpose consisting in attaching to the pre-existing triple valve, as patented in number 220,556, a machine which embraced an additional stem, an additional valve and additional air passages leading from the port in the new valve to the brake-cylinder. This

new attachment is put into action for emergency purposes by th
triple-valve piston when on its extreme transverse. The previou
machine 220,556 had provided for the extreme traverse of tha
piston by which it had put in action the main valve at the end
its old stem, and opened a full and direct flow of compressed a
from the auxiliary reservoir into the brake-cylinder for the use i
emergencies. Thus the new contrivance, by the same extrem
traverse of the triple-valve piston, continued the old flow of con
pressed air for emergency purposes and provided an additional flo
of the air for emergency purposes by an additional mechanism; th
latter flow being directly from the train-pipe, and the former flo
being from the auxiliary reservoir. Such was the make-up of pater
360,070—two machines in one box or case. It was found, o
thorough and conspicuous trials, to be imperfect and inefficient, an
lacked that essential element of patented devices—utility. But
contained a valuable invention, and was afterwards to improved i
details, when patented in number 376,837, as to become
1412 machine of great value to the public, a supplemental pisto
being supplied in 376,837.

Boyden also made a successful invention of venting compress
air from the train-pipe into the brake-cylinder of each car simult
neously with venting air from the auxiliary reservoir to the brak
cylinder, as had been done for emergency purposes by the previo
triple valve of patent 220,556. He did not resort to a secon
machine. He — not devise an additional stem, an additional valv
or by-passages independent of those of the triple valve. He accon
plished the transmission of compressed air directly from the trai
pipe to the brake-cylinder by other means. He inserted a partiti
in the from of a brass ring into the triple valve of patent 220,5
itself, between the chamber containing the valves and the compress
air of the auxiliary reservoir on one hand and the chamber of t
piston containing train-pipe air on the other, and he opened a p
in that partition for the passage of compressed air from the trai
pipe to the brake-cylinder. He thereby so provided that where
Westinghouse's device employed a fourth valve, another stem a
newly contrived by-passages for discharging compressed air fro
the train-pipe into the brake-cylinder, organized separately in
second machine; Boyden contrived to discharge both train-pipe
and auxiliary reservoir air simultaneously into the brake-cylind
without using an additional stem or valve or by-passages. T
devices of Westinghouse and Boyden are exhibited by the diagra
on the sheet inserted between pages 34 and 35 of appellant's (Boyd
principal brief, and is attached to this statement. Let these diagra
be made a part of this opinion.

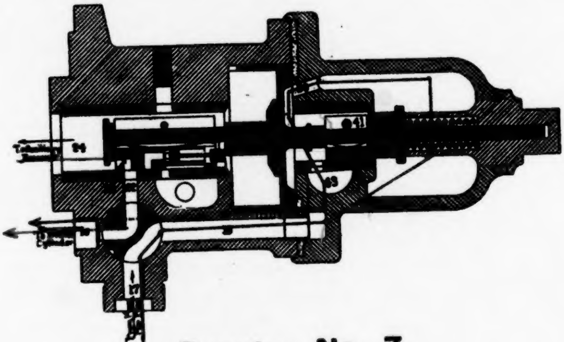
(Here follow diagrams marked pp. 1413 & 1414.)

It is not for us to describe how the introduction of train-pipe
into the brake-cylinder of each car quickens the action of the brak
which are already subject to the action of air from the auxilia
reservoir. It is sufficient to say that the engineer, by means of

Nos. 403 & 426
Westinghouse Co.
v.
Boyden Co. } p. 1413

To face page 14

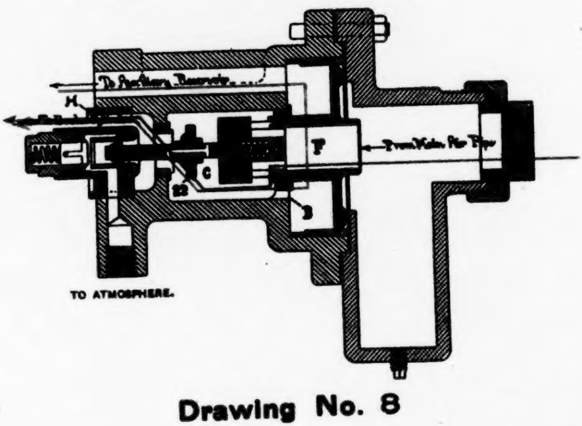
Complainant's Patent No. 360,070.



Drawing No. 7.

NOTE.—The Check-Valve 49 is located back of the passage 18 and therefore is not visible on Cut 7.

Defendant's Structure Plate XI.

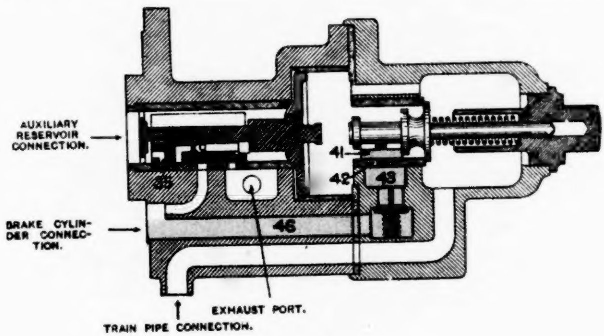


Drawing No. 8

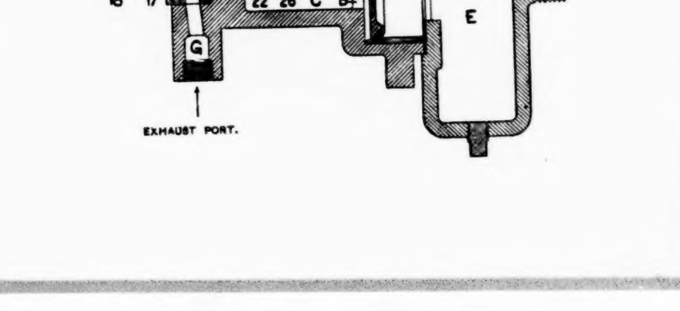
To face page 15.

Nos. 403 & 426.
Westinghouse Co. v. Boyden Co. } p. 1414

Complainant's Patent in Suit, No. 360,070.



Defendant's Structure, Plate XI.



valve on the engine and by means of the branch pipe leading from the train-pipe to the triple valve of each car, can, by the improvements in controversy, vent the air of the train-pipe directly and more promptly into the brake-cylinder, and thus more quickly apply the brakes, than he can by the indirect conduit opened by the main valve of 220,556 into the brake-cylinder from the auxiliary reservoir when its piston is in extreme traverse, as heretofore described. Quick action being the desideratum, the engineer effects it more promptly by the direct means than by the indirect.

1415 *Opinion.*

HUGHES, *J.*:

The foregoing statement of facts and explanation of the devices upon which the decision of this case depends is of unusual length, which has been a necessary result of the extraordinary magnitude of the record and the unusual number and volume of the briefs of counsel in the case; but it has been prepared at the expense of very much labor, and is, we trust, *we trust*, sufficiently correct to warrant the conclusions of law *of* which we have founded upon them.

Of the technical "claims" set out by Westinghouse in his application for the patent, number 360,070, those numbered 1, 2 and 4 are the special subjects of this suit. The device described in these claims is the one which Westinghouse charges in the bill of complaint in this case to have been infringed by the Boyden invention. The three "claims" are as follows, and the words in italics indicate the device charged to have been infringed:

"1. In a brake mechanism, the combination of a main air pipe, an auxiliary reservoir, a brake-cylinder, a triple valve, *and an auxiliary-valve device, actuated by the piston of the triple valve and independent of the main valve thereof, for admitting air in the application of the brake, directly from the main air pipe to the brake-cylinder*, substantially as set forth.

"2. In a brake mechanism, the combination of a main air pipe, an auxiliary reservoir, a brake-cylinder, and a triple valve having a piston whose preliminary traverse admits air from the auxiliary reservoir to the brake-cylinder, *and which by a further traverse admits air directly from the main air pipe to the brake-cylinder*, substantially as set forth.

"4. The combination, in a triple-valve device, of a case or chest, a piston fixed upon a stem and working in a chamber therein, a valve moving with the piston-stem and governing ports and passages in the case leading to connections with an auxiliary reservoir and a brake-cylinder and to the atmosphere, respectively, *and an auxiliary valve actuated by the piston stem and controlling communication between passages leading to connections with a main air pipe and with the brake cylinder, respectively*, substantially as set forth."

The phrase "substantially as set forth" is technical, and is equivalent to saying "by the means described in the text of the in-

ventor's application for letters patent, as illustrated by the
1416 drawings, diagrams, and models which accompany the application." These words limit the general terms of the specification which set out the *function* performed by the invention, and confine the inventor's rights to his own *means* or their mechanical equivalent of performing the function.

It is unnecessary to set *in totidem verbis* the technical "claims" in which Boyden summarized his application to the Patent Office. Suffice it to say, that his device, original and improved, which is represented in the patents issued to him as numbers 481,134, 481,135, and 481,136, dated August 16, 1892, provided for the admission by a single valve, integral with the triple valve, of both train-pipe air and auxiliary reservoir air to the brake-cylinder for emergency stops. He accomplished this object as Westinghouse did, by a device acted upon by the triple-valve piston when at the same extreme traverse at which it had been previously used for emergency work. As to using this extreme traverse, described in the patent which expired, number 220,556, he did what Westinghouse did; but the object of either being the discharge of train-pipe air into the brake-cylinder (which was new) simultaneously with the discharge of auxiliary reservoir air into that cylinder (which was old), Boyden invented a partitioning ring in the old triple valve to divide the chamber of the three valves from the chamber of the piston, and opened in this ring a port through which the train-pipe air might pass from the piston chamber through the chamber of the valves to the brake-cylinder; while Westinghouse attached an additional individual machine to patent 220,556, consisting of a stem moved by the main piston in extreme traverse, an additional valve, and additional independent by-passages leading from the additional valve to the brake-cylinder. The same *result* was accomplished by the two devices, but these had but one means in common. Each used one common mechanical movement of the main piston, which was a movement described in the patent which has expired. But the further mechanism employed, respectively, by the two inventions were, respectively, as has been described.

The transmission of train-pipe air and auxiliary reservoir air simultaneously to the brake-cylinder is a *result* of function and is not patentable. The *means* by which this or any other result or function is accomplished may be many and various, and if these several means are not mechanical equivalents, each of them is patentable. The question at bar is, whether Boyden's brass-ring partition with the port it contains, inserted in and made a part of the triple valve itself, successfully accomplishing the
1417 function of discharging train-pipe air into the brake-cylinder simultaneously with the triple valve's discharge of auxiliary reservoir air into that cylinder, is the mechanical equivalent of Westinghouse's attached machine, non-integral, segregate and individual, consisting of another stem, another valve, and by-passages peculiar to itself leading from the additional valve to the brake-cylinder; both devices being put in action by the triple-valve piston when on its old extreme traverse.

This question was presented necessarily to the Patent Office of the nited States when Boyden applied for a patent for the device nder consideration. That office employs the best experts in meanics which it can secure in this and other countries. Its examinations are indeed *ex parte* in form, but they are, nevertheless, onducted under hot and skilled contestation in every case of imortance, and its decisions, though not conclusive, are entitled to reat respect. That office, after full examination, awarded a patent o Boyden on the 16th day of August, 1892, for his quick-action mprovement on the device of patent 220,556, and that action by he office was, in effect, a ruling that the Boyden device did not nfringe Westinghouse's quick-action patent number 360,070. That uling takes rank here as the testimony of experts of the highest xperience, skill and knowledge in mechanics. That ruling was ubsequent to the issuing to Westinghouse of both the patents, umbers 360,070 and 376,837, four years after the latter patent, vhen the Patent Office had full knowledge of them.

The circuit — held, in its decision of this case, that the Boyden levice was the functional equivalent of that of Westinghouse, as lescribed in claim 2 of patent 360,070; that both devices depended upon the extreme traverse of the triple-valve piston of patent 220,556, and that this traverse was new and unusual. It held virtually that the novelty of this extreme traverse, on which both the quick-action devices of the two inventions depended, and their functional equivalency made Boyden's device an infringement of Westinghouse's. That the mechanism of Boyden differed from that of Westinghouse, so far as the mechanical means which was used in availing of the extreme traverse was concerned, does not seem to have been controverted by the circuit court. But it held, virtually, that because the extreme traverse was new and was a pioneer invention of Westinghouse and was necessary to put both of the two devices into action, and because the means devised for utilizing the extreme traverse in emergency work were functional equivalents of Westinghouse's: therefore Boyden's device was an infringement.

1418 It is obvious to us that the circuit court erred in interpreting the patent in suit by imputing novelty to the extreme traverse of the triple-valve piston, because this was shown in the prior patent 220,556 and its predecessor, 168,359. That machine, 220,556, was designed both for graduated braking and for emergency braking. The former was provided in the sensitive valve inserted in the stem of the triple-valve piston, through which compressed air was vented, in quantity graduated at the will of the engineer, from the auxiliary reservoir into the brake-cylinder. But this earlier and expired patent contained more than the sensitive valve in the stem of the piston, and more room in the piston chamber than was necessary for a partial traverse of the piston. It contained a main valve and a sufficient prolongation of the piston chamber for the extreme traverse. This main valve and this prolongation of the chamber were entirely useless for graduated work, and was intended and employable only for emergency work. The

main valve would not have been contrived nor the chamber prolonged except for the purpose, by giving the piston its extreme traverse in the extended chamber, and thus bringing the main valve into action, of fitting it for emergency work. The machine patented as Nos. 168,359 and 220,556 did good emergency work in short trains, and the extreme traverse of the piston was constantly employed in that work; and this employment of it was not "unusual." But in long trains, and especially in long trains of heavy freight cars, it failed to do emergency work with sufficient quickness. The emergency apparatus, however, was there, to wit: the main valve and the extended chamber. They had been patented, and the patent has expired. The extreme traverse of the piston in its extended chamber for emergency use, was as old as the expired patent, No. 220,556. The circuit court, therefore, erred in supposing and ruling that it was new and unusual.

As there was no novelty in the extreme traverse of the old triple-valve piston it must be eliminated from consideration, and the mechanical equivalency of Boyden's device of the partitioning ring integral with the triple valve itself on one hand, and on the other hand the Westinghouse device attached to the triple valve, and consisting wholly of apparatus not integral, but segregate, individual, several, additional to and independent of it—depends upon the character of the two devices themselves, considered and compared apart from the extreme traverse, and not upon their being put into action by the extreme traverse of the triple-valve piston. Comparing the two devices apart from the triple-valve piston in
1419 extreme traverse, we are unable to entertain a doubt that the ruling of the Patent Office was correct to the effect that Boyden's device was not the mechanical equivalent of that of Westinghouse. They seem to us to differ as widely from each other as two devic-s for accomplishing the same result can well differ.

We think that when claim 2 of 360,070, in its language describing the action of that device, failed to describe any means by which the extreme traverse of the piston produced it, declaring merely that the piston, "by a further traverse, admits air directly from the main air pipe to the brake-cylinder," it was fatally defective, claiming only a result which is public property and not identifying the specific means (his own property) by which the result is achieved.

That this invention of Westinghouse, thus undefined, is one of the highest value to the public, and that — is a pioneer one in the art of quick-action air-brakes is not denied, and is conceded. It is conspicuously one of those pioneer inventions which entitle the proprietor to a liberal protection from the courts in construing the claim. But there is a limit to the judicial liberality in this direction. If an inventor is ambiguous or obscure, or halt or limp in his language of description, the courts will help him out and so construe the claim as to give distinct identity to his device. If there be a doubt in the mind of the court or of a jury on the issue of mechanical equivalency, the court will give, and instruct the jury to give, the benefit of the doubt to the pioneer inventor. But where the inventor falls so far short in his description as to claim only the

result which his machine accomplishes, and omits an explicit definition of the *means* by which he does it, as in the case at bar, the courts have another duty to perform, one which they owe to the public and to the worthy fraternity of inventors, and must decline to give him general rights where he is entitled only to special rights.

The inventor in the present case seemed himself to feel that his claim was too broad in terms. In his original application for patent 360,070 his first claim was couched in this language: "In a brake mechanism, the combination of a main air pipe, an auxiliary reservoir, a brake-cylinder, and a triple valve provided with a device for admitting air directly from the main air pipe to the brake-cylinder." This language covered *any device* which might accomplish the object mentioned, and he found it necessary to erase it from his specification, and to substitute claim 1 as it now stands.

In the same specification Westinghouse had also used this language: "Further, while in the specific construction described and shown, the function of admitting air from the
1420 main pipe is performed by a valve *separate* from that which effects the preliminary admission of reservoir pressure to the cylinder, a modification in which the same office is performed by a valve *integral* with the main valve and formed by an extension thereof, would be included in and embody the essential operative features of my invention." Here again was a claim for a function irrespectively of the mechanical means used in accomplishing it, which the inventor found it necessary to erase from his specification. In the suit at bar he virtually asks the court to restore to his claim the two erasures which he felt himself unable to sustain at the Patent Office. Our duty to the public and to inventors at large forbids our doing so.

Some notice is proper, in this connection, of the contention of appellees (Westinghouse), that the additional valve, four, in the additional stem of the quick-action apparatus attached to the original triple valve 220,556, by Westinghouse in patent 360,070, is the mechanical equivalent of the poppet valve of Boyden which he designates as 22 in the triple valve of 220,556 as he improves it in his device. This contention is urged on the ground, as alleged, that Boyden makes it perform the same purpose which Westinghouse's fourth valve performs in his attached apparatus. But Boyden simply substituted in the original triple valve his poppet valve 22 for the slide-valve which is the main valve of patent 220,556. Boyden's is not an "auxiliary" valve; it is mechanically the original main valve of the original triple valve, and it performs the service which is performed by the main valve of 220,556. It is not the mechanical equivalent of valve four in the attached apparatus of Westinghouse simply by reason of its taking part in an emergency service in admitting train-pipe air into the brake-cylinder. In the original triple valve it performed no other service than admitting auxiliary reservoir air into the brake-cylinder; in Boyden's device it continues to perform that service, and is made incidentally instrumental in allowing the passage of train-pipe air. The performance incidentally of quick-action service does not make it an auxiliary valve. It

is the same valve. The incidental *service* is auxiliary, but the valve itself is the same and unchanged. We think the circuit court was correct in its view that the poppet valve 22 of Boyden is the original main valve of 220,556.

We think the circuit court was correct in ruling that Boyden's invention under consideration does not infringe claim 1 of Westinghouse. The language of that claim, in defining the ad-
1421 ditional apparatus of Westinghouse embraced in patent
360,070, is, "and an auxiliary-valve device, actuated by the piston of the triple valve and independent of the main valve" for admitting air directly from the train-pipe to the brake-cylinder. Obviously there is no "auxiliary valve" "independent of the main valve" in the Boyden device, and, we think, the ruling was correct. The case is similar in respect to claim 4 of Westinghouse. The language there is, "and an auxiliary valve actuated by the piston stem and controlling communication between passages leading to connections with a main air pipe and with the brake-cylinder." None of these terms can be fairly applied to the Boyden device or to any of its details; and we think that the circuit court ruled correctly in holding that claim 4 is not infringed by Boyden.

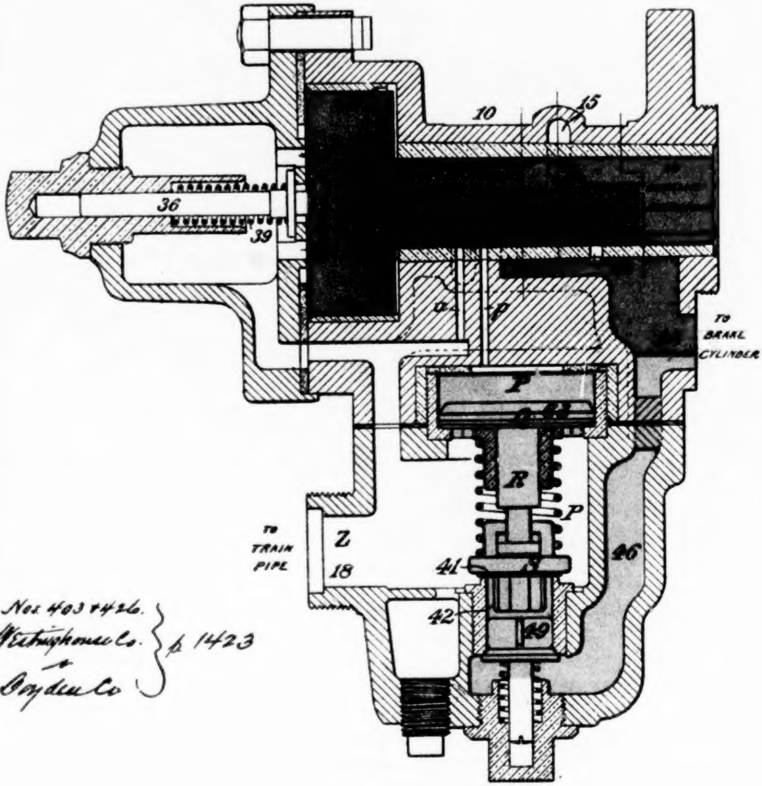
The distinction suggested by the circuit court between inventions employing cranks and levers visible to the senses, and those employing compressed air which operates by modes not visible to the senses,—as to which latter devices, the circuit court held that "in judging of an infringement we are to direct our attention rather to *functional* equivalents than to *mechanical* equivalents,"—we do not think well taken even in favor of pioneer inventions. The Supreme Court in its ruling in the great leading case of *O'Reilly v. Morse*, 15 Howard, 62, which was one in which the far more subtile agency of electricity was under consideration, neither made nor intimated such a distinction.

As to the adjudications in the Federal courts of the southern district of New York, on the subject of the air brakes invented by Westinghouse, it is incumbent upon us to consider whether the questions now before this court are in any respect *res judicata* and binding precedents in the case at bar. Technically they are not. The patent charged to have been infringed, in the first suit in the circuit court of New York, and on appeal in the appellate court of that circuit, was that taken out by Westinghouse, as number 376,837. That patent contained an important, indeed a vital, improvement upon number 360,070, which is in suit here, and which was found in practice to be insufficient for its purposes. It contained a supplemental or auxiliary piston, as well as an additional stem, an additional valve, and independent by-passages, composing an additional segregate machine, as we have before mentioned. In the second suit before the New York circuit and appellate courts, the parties complainant and defendant being the same and the defendant's invention being substantially the same, suit was based upon two patents of Westinghouse, numbers 360,070 and 376,837, and also upon a patent issued to H. S. Park, numbered 393,784.
1422 The question in both suits was, whether the air brake con-

To face page 22.

NEW YORK AIR BRAKE CO'S VALVE.

Decreed by Judge Lacombe to Infringe Patent No. 360,070, because it contains the "additional members" of that Patent.



Nos 403 & 426.
Westinghouse Co. & Boyden Co } p 1423

The upper part of the mechanism in the above cut (colored blue) constitutes the "triple valve;" said parts are numbered 10, 11, 12, 14, 20, 36, 39 and 51.

The lower part (colored red,) infringes the Westinghouse invention because it includes the "additional members," a separate "auxiliary valve 41" and *passage* 46, leading from the train-pipe direct to the brake-cylinder.

It will be seen the above structure has the "two machines," the blue and the red the same as Patent 360,070, whereas Defendants' Structure Plate XI here in suit, has only one—the blue, and—therefore is minus the "additional members."

trived by the defendant in those suits had infringed the three patents. Judge Lacombe, who was affirmed on appeal, described the machine of the defendant there as having "the main air pipe (train-pipe), an auxiliary reservoir, a brake-cylinder, a triple valve"—the latter being the old triple-valve mechanism of patent 220,556, "and an auxiliary-valve device, independent of the main valve, for admitting air in the application of the brake directly from the main air pipe to the brake-cylinder." A diagram which illustrates this additional and "auxiliary-valve device, independent of the main valve" of the defendant in the New York suits, is given in the second brief or "oral argument" for appellants (Boyden) here, opposite page 36, and is attached to and made a part of this opinion.

(Here follows diagram marked p. 1423.)

It will be apparent, from an inspection of this diagram, that no decision affecting that device can effect one as different from it structurally and in every respect as is that of the Boyden device. It would require the verdict of a jury and the conclusive testimony of experts upon the question of mechanical equivalency to enable a court to decide whether they present a case of *res judicata*.

Prima facie, a decision founded upon one patent not in suit here, and another decision founded upon three patents collectively, one only of which is in suit here, the two decisions declaring that an invention used by a defendant who is not the defendant here, against the machine of that defendant differing widely in its structure from the one complained of here, cannot be treated as binding in the decision which this court may feel bound to render in the suit at bar.

Here it is contended that the mere use of the extreme traverse of the triple-valve piston to effect the same *functional* result, which was effected by Westinghouse in 360,070, constitutes an infringement, irrespectively of the additional means employed. There it was ruled that the use of the extreme traverse *and* of an additional machine attached to the original 220,556, which was structurally and *mechanically* equivalent to 360,070, was an infringement of the latter patent. The cases are different and not on all-fours with each other, and do not control or affect our own ruling.

Decrees will be entered, in accordance with the views expressed in this opinion, affirming the ruling of the court below in respect to claims *one* and *four* of the complainant's patent, number 360,077, and reversing the ruling of the court below in respect to claim *two* of the said patent.

1424 At the same term, to wit: November 11, 1895, the court here made and entered the following decree, to wit:

Decree.

United States Circuit Court of Appeals, Fourth Circuit.

BOYDEN POWER BRAKE COMPANY *et al.*, Appellants, *vs.* WESTINGHOUSE AIR BRAKE COMPANY *et al.*, Appellees, and WESTINGHOUSE AIR BRAKE COMPANY *et al.*, Appellants, *vs.* BOYDEN POWER BRAKE COMPANY *et al.*, Appellees.	Nos. 131 and 134.

Appeal and cross-appeal from the circuit court of the United States for the district of Maryland.

This cause came on to be heard on the transcript of the record from the circuit court of the United States for the district of Maryland, and was argued by counsel.

On consideration whereof, it is now here ordered, adjudged, and decreed by this court, that the decree of the said circuit court, in this cause, be, and the same is hereby, affirmed with respect to claims one and four of the complainant's patent number 360,–70, and reversed with respect to claim two of the said patent. And this cause is remanded to the circuit court of the United States for the district of Maryland with direction to enter a decree therein in conformity with the opinion and decree of this court. Costs in this court to be paid by Westinghouse Air Brake Company.

It is further ordered that the mandate of this court issue after the expiration of twenty days from the date hereof.

CHARLES H. SIMONTON,
Circuit Judge.

November 11th, 1895.

1425 *Petition to Stay Mandate.*

Filed November 25, 1895.

United States Circuit Court of Appeals, Fourth Circuit.

BOYDEN POWER-BRAKE COMPANY *et al.*, Appellants, *vs.* WESTINGHOUSE AIR-BRAKE COMPANY *et al.*, Appellees.	No. 131. Appeal from the Circuit Court of the United States for the District of Maryland.
WESTINGHOUSE AIR-BRAKE COMPANY *et al.*, Appellants, *vs.* BOYDEN POWER-BRAKE COMPANY *et al.*, Appellees.	No. 134. Cross-appeal from the Circuit Court of the United States for the District of Maryland.

Motion for stay of mandate.

And now, to wit, come The Westinghouse Air Brake Company and George Westinghouse, Jr., appellees in cause No. 131, and appellants in cause No. 134, by George H. Christy, their counsel, and move the court that the mandates in said causes be stayed for such time as to the court may seem meet, to the end that the said movers herein may, before the issue of such mandates, have time to prepare and present to the supreme court their petition for a writ of *certiorari* therein, with reasonable allowance of time for the action of said court thereon.

And said counsel hereby certifies to the court that no injunction was issued against defendants from the court below, so that the defendants are not now and have not been under injunction at any time herein—this fact having also been stated and admitted in open court at the hearing in this court.

GEORGE H. CHRISTY,
Att'y for Westinghouse Air Brake Co. and George Westinghouse, Jr.

Pittsburg, Pa., Nov. 23, '95.

1426 *Objections to Stay of Mandate.*

Filed Dec. 5, 1895.

United States Circuit Court of Appeals, Fourth Circuit.

BOYDEN POWER-BRAKE COMPANY *et al.*, Appellants, *vs.* WESTINGHOUSE AIR-BRAKE COMPANY *et al.*, Appellees.	No. 131. Appeal from th Circuit Court of th United States for th District of Maryland.
WESTINGHOUSE AIR-BRAKE COMPANY *et al.*, Appellants, *vs.* BOYDEN POWER-BRAKE COMPANY *et al.*, Appellees.	No. 134. Cross-appea from the Circuit Cour of the United States fo the District of Mary land.

To the Hon. Nathan Goff, justice of the cir. ct. of appeals for th fourth circuit.

SIR: We desire to appear before your honor, by counsel, for th purpose of opposing the motion made by Westinghouse for a sta of mandate in the above-entitled cause.

We suggest that Wednesday, December 4th, 1895, would be convenient day, this date giving both sides time for preparation, o any other date that may be convenient for your honor.

We respectfully request that your honor will indicate to us th time and place for the hearing.

A copy of this notice is this day mailed to Geo. H. Christy, Esq attorney for Westinghouse Air Brake Co. and Geo. Westinghous Jr., at Pittsburg, Pa.

Respectfully,

BOYDEN BRAKE CO.
G. H. BOYDEN, *Pres't.*

Baltimore, Md., November 26th, 1895.

1427 *Order of Court Refusing Stay of Mandate.*

Filed Dec. 5, 1895.

United States Circuit Court of Appeals, Fourth Circuit.

BOYDEN POWER-BRAKE COMPANY *et al.*, Appellants, *vs.* WESTINGHOUSE AIR-BRAKE COMPANY *et al.*, Appellees.	No. 131. Appeal from the Circuit Court of the United States for the District of Maryland.
WESTINGHOUSE AIR-BRAKE COMPANY *et al.*, Appellants, *vs.* BOYDEN POWER-BRAKE COMPANY *et al.*, Appellees.	No. 134. Cross-appeal from the Circuit Court of the United States for the District of Maryland.

The motion made by The Westinghouse Air Brake Company and George Westinghouse, Jr., appellees in said cause No. 131, and appellants in cause No. 134, to stay the mandates therein for such time as will enable counsel to prepare and present to the Supreme Court a petition for a writ of *certiorari*, with reasonable allowance of time for the action of said court thereon, was this day heard, counsel for said parties, respectively appellants and appellees, being present, on consideration whereof, it is ordered that said stay be refused, and the clerk is directed to send down the mandates aforesaid as heretofore provided for.

NATHAN GOFF,
Circuit Judge.

Dec. 5th, 1895.

1428 *Mandate.*

Issued — filed Dec. 9, 1895.

UNITED STATES OF AMERICA, *ss:*

Seal of the Court. The President of United States of America to the honorable judges of the circuit court of the United States for the district of Maryland, Greeting:

Whereas, lately in the circuit court of the United States for the district of Maryland, before you, or some of you, in a cause between George Westinghouse, Jr, and Westinghouse Air Brake Co., complainants, Boyden Power Brake Company, *et al.*, defendants, wherein the decree of the said circuit court entered in the said cause on the 25th day of April, 1895, is in the following words, to wit:

And now, to wit, this 25th day of April, 1895, the above-entitled cause having come on regularly for hearing, before the Honorable

Thomas J. Morris, district judge, holding circuit court, on bill, answer, replication and proofs taken by and on behalf of the respective parties hereto, and having been argued by Mr. George H. Christy and Mr Frederic H. Betts for complainants, and by Mr. Lysander Hill, Mr. Skipwith Wilmer and Mr. Hector T. Fenton for defendants, and the court having considered the same, and being duly advised in the premises, it is thereupon ordered, adjudged and decreed:

1st. That the letters patent recited in complainants' bill of complaint, to wit, letters patent of the United States, No. 360,070, dated March 29, 1887, and granted to George Westinghouse, Jr., for a new and useful improvement in fluid-pressure automatic brake mechanism, are a good and valid patent in all respects as regards and to the extent of the subject-matter of invention referred to and summed up in the several claims declared upon herein, to wit: claims numbered one, two and four of said recited patent; that George Westinghouse, Jr., was the true, original and first inventor thereof; and that the complainants have a good and sufficient title thereto, and are entitled to the exclusive right therein and thereunder.

2nd. That the defendants above named by the manufacture, use and sale of fluid-pressure automatic brake mechanism, as set forth and shown in and by the proofs herein, and (for greater certainty herein) more particularly as shown and described in certain
1429 letters patent of the United States, No. 481,134 and No. 481,135, both dated August 16, 1892, and both granted to The Boyden Brake Company, assignee of George A. Boyden, defendants herein, having infringed the said second claim of said recited patent No. 360,070, and have violated the exclusive right of the complainants therein and thereunder, and that a writ of injunction, conformable to the prayer of said bill, and in the usual form, be issued by the clerk, perpetually enjoining and restraining the said defendants, and each of them from any further manufacture, use or sale of the apparatus, mechanism and devices complained of herein and of any other apparatus, mechanism or devices substantially such in construction and operation as that which is referred to in and constitutes the subject-matter of said second claim, and from doing any act or thing in infringement of said second claim, or violation of the exclusive right so as aforesaid vested in said complainants therein and thereunder.

3rd. That reference be made herein to G. Morris Bond, Esq., as master, to take, state and make return of an account of the gains and profits made by said defendants, as also of the damages suffered by said complainants by or on account of said infringement, and that the parties appear before the master and produce books and papers and render accounts as he may, from time to time, direct.

4th. That as regards claims one and four of said patent No. 360,070, the court being of the opinion that defendants' device hereinbefore referred to does not infringe the same, injunction is refused and the bill of complain*ant* is, in reference to such claims, hereby dismissed.

5th. And it is further ordered that all questions of the allowance

osts are reserved until the final decree; as by the inspection of transcript of the record of the said circuit court, which was ught into the United States circuit court of appeals, for the fourth uit by virtue of the appeal of the Boyden Power Brake Company *l.*, and the cross-appeal of George Westinghouse, Jr., and the stinghouse Air Brake Company agreeably to act of Congress in h case made and provided, fully and at large appears.

And whereas, in the term of May, in the year of our Lord, one usand eight hundred and ninety-five, the said cause came on to heard before the said United States circuit court of appeals for fourth circuit, on the said transcript of record, and was argued counsel:

On consideration whereof, it is now here ordered, adjudged
30 and decreed by this court, that the decree of the said circuit court, in this cause, be and the same is hereby affirmed with spect to claims one and four of the complainants' patent number 0,070, and reversed with respect to claim two of the said patent. nd this cause is remanded to the circuit court of the United States r the district of Maryland with direction to enter a decree therein conformity with the opinion and decree of this court. Costs in is court to be paid by the Westinghouse Air Brake Company. It further ordered that the mandate of this court issue after the exiration of twenty days from the date hereof.

CHARLES H. SIMONTON,
Circuit Judge.

November 11th, 1895.

You, therefore, are hereby commanded that such further proceedngs be had in said cause, in conformity with the opinion and deree of this court as according to right and justice, and the laws of he United States, ought to be had, the said appeal and cross-appeal otwithstanding.

Witness the Honorable Melville W. Fuller, Chief Justice of our Supreme Court, the ninth day of December, in the year of our — one thousand eight hundred and ninety-five.

HENRY T. MELONEY,
Clerk of the U. S. Circuit Court of Appeals for the Fourt- Circuit.

Costs of Boyden P. B. Co.

Clerk	$52 45
One-half printing record	104 50
Attorney	20 00
	$176 95

February 17, 1896, writ of certiorari of the Supreme Court of the United States, dated January 30, 1896, was produced removing the aforesaid causes into the said Supreme Court.

1431 & 1431½ UNITED STATES OF AMERICA:

I, Henry T. Meloney, clerk of the United States circuit court of appeals for the fourth circuit, do certify that the aforegoing is a true transcript of the entire record and proceedings of the said circuit court of appeals in the therein-entitled causes as the same remains upon the files and records of the said circuit court of appeals.

Seal United States Circuit Court of Appeals, Fourth Circuit.

In testimony whereof I hereto set my hand and affix the seal of the said United States circuit court of appeals for the fourth circuit, at Richmond, this 19th day of February, A. D. 1896.

HENRY T. MELONEY,
Clerk United States Circuit Court of Appeals for the Fourth Circuit.

1432 UNITED STATES OF AMERICA, *ss:*

The President of the United States of America to the honorable the judges of the United States circuit court of appeals for the fourth circuit, Greeting:

[Seal Supreme Court of the United States.]

Being informed that there is now pending before you a suit in which Boyden Power Brake Company *et al.* are appellants and George Westinghouse, Jr., and The Westinghouse Air Brake Company are appellees and George Westinghouse, Jr., and The Westinghouse Air Brake Company are appellants and Boyden Power Brake Company *et al.* are appellees, which suit was removed into the said circuit court of appeals by virtue of an appeal and cross-appeal from the circuit court of the United States for the district of Maryland, *and* we, being willing for certain reasons that the said cause and the record and proceedings therein should be certified by the said circuit court of appeals and removed into the Supreme
1433 Court of the United States, do hereby command you that you send without delay to the said Supreme Court as aforesaid the record and proceedings in said cause, so that the said Supreme Court may act thereon as of right and according to law ought to be done.

Witness the Honorable Melville W. Fuller, Chief Justice of the United States, the 30th day of January, in the year of our Lord one thousand eight hundred and ninety-six.

JAMES H. McKENNEY,
Clerk of the Supreme Court of the United States.

1434 [Endorsed:] Supreme Court of the United States. No. 847. October term, 1895. Boyden Power Brake Company *et al. vs.* George Westinghouse, Jr., *et al.* Writ of certiorari. The execution of the within writ appears from the certified transcript of the record in the causes therein mentioned, which said transcript is

ereto annexed. Henry T. Meloney, clerk U. S. circuit court of appeals, 4th circuit. February 19, 1896.

Endorsed on cover: Case No. 16,137. U. S. circuit court of appeals, fourth circuit. Term No., 403: Boyden Power Brake Company *et al.*, appellants, *vs.* George Westinghouse, Jr., and The Westinghouse Air Brake Company. Case No. 16,168. Term No., 426: George Westinghouse, Jr., *et al.*, appellants, *vs.* Boyden Power Brake Company *et al.* Writ of certiorari and return. Filed February 20, 1896.

99
~~847~~
1403

United States Supreme Court.

In the Matter of the Petition

OF

GEORGE WESTINGHOUSE, Jr., and THE WESTINGHOUSE AIR BRAKE COMPANY for a Writ of Certiorari, etc.

PETITION.

GEORGE H. CHRISTY,
Solicitor for Petitioners,

FREDERIC H. BETTS,
J. SNOWDEN BELL,
BERNARD CARTER & SONS,
Of Counsel.

C. G. Burgoyne, Cor. Centre and Walker Sts., N. Y.

'o THE SUPREME COURT OF THE UNITED STATES OF AMERICA:

'he petition of George Westinghouse, Jr., and The Westinghouse Air Brake Company, for a writ of *certiorari*, directed to the United States Circuit Court of Appeals for the Fourth Judicial Circuit, under the provisions of Section 6 of the Act of Congress, approved March 3d, 1891, and ordering that the Records in a certain appeal and cross-appeal be certified to this Honorable Court for its review and determination.

Said appeal is entitled as follows:

Boyden Power Brake Company, George A. Boyden, President; Charles B. Mann, Secretary; William Whitridge, Treasurer; and Boyden Brake Company, Defendants and Appellants, versus George Westinghouse, Jr., and The Westinghouse Air Brake Company, Complainants and Appellees, No. 131, in said Circuit Court of Appeals.

And the said cross-appeal is entitled as follows:

George Westinghouse, Jr., and The Westinghouse Air Brake Company, Complainants and Appellants, versus Boyden Power Brake Company, George A. Boyden, President; Charles B. Mann, Secretary; William Whitridge, Treasurer; and Boyden Brake Company, Defendants and Appellees, No. 134, in said Circuit Court of Appeals.

Statement of Case.

And your said petitioners thereupon respectfully show to this Honorable Court, as follows:

FIRST. Your petitioners are, and at the time hereinafter mentioned were, citizens of the State of Pennsylvania—the said The Westinghouse Air Brake Company being a corporation duly organized under the laws of said State.

SECOND. Your petitioners, complainants therein, brought suit by bill in equity in the U. S. Circuit Court for the District of Maryland,

for infringement of certain Letters Patent of the United States, against the Boyden Power Brake Company, George A. Boyden, President, Charles B. Mann, Secretary and William Whitridge, Treasurer, defendants therein. By subsequent proceedings, Boyden Brake Company became also a party defendant. All the said parties defendant were citizens of the State of Maryland, and the said Boyden Power Brake Company and Boyden Brake Company were, and so far as is known, still are, corporations organized under the laws of the said State of Maryland.

THIRD. The patent for infringement of which the said suit was brought and prosecuted is Letters Patent of the United States No. 360,070, granted to George Westinghouse, Jr., one of your petitioners, March 29th, 1887, for an Improvement in Fluid-Pressure Automatic Brake Mechanism, the title whereof was, at the time of bringing said suit, duly vested in your petitioners, complainants therein. And infringement was charged of claims 1, 2 and 4 of said patent.

FOURTH. In due time, the said cause came on for hearing on bill, answer, replication and proofs, and was argued before the Honorable THOMAS J. MORRIS, holding Circuit Court. An opinion therein was subsequently rendered by His Honor Judge MORRIS, and a decree was entered in conformity therewith—holding, *inter alia*, that the said Letters Patent No. 360,070 was a good and valid patent; that complainants had a good title thereto; that the defendants therein had not infringed claims 1 and 4 of said patent, but had infringed claim 2 of said patent. As to claims 1 and 4, the bill was dismissed, but as to claim 2 an injunction was allowed, with reference to a Master for an account.

The opinion of the Court therein is reported in 66 Fed Rep., 997, and a copy is annexed as an exhibit hereunto.

FIFTH. Thereupon each party appealed to the Circuit Court of Appeals for the Fourth Circuit.

The defendants therein, Boyden Power Brake Company *et al.* appealed under Section 7 of the Circuit Court of Appeals Act of March 3d, 1891, from so much of the said decree as granted or allowed an injunction under claim 2 of said Patent No. 360,070. Said appeal is the case first above recited, and was docketed in said Court of Appeals as No. 131.

The complainants therein, your petitioners herein, appealed from so much of said decree as *refused* an injunction under claims 1 and 4 of said Patent No. 360,070—and this, under the amendment to said act, approved February 18th, 1895, providing for such appeals—this last appeal being the cross-appeal above recited, and docketed in said Court of Appeals as No. 134.

SIXTH. The said appeals came on for hearing in the said Court of Appeals, before the Honorable Circuit Judges GOFF and SIMONTON and District Judge HUGHES, and were argued in said Court as one case.

Subsequently, and on or about the eleventh day of November, 1895, the opinion of the Court was rendered therein by his Honor Judge HUGHES, *inter alia*, affirming the decree of the Circuit Court under claims 1 and 4 of said patent, and reversing the decree of the said Court under claim 2 of said patent.

SEVENTH The said recited Patent No. 360,070 is confessedly the "ground floor" or "pioneer" patent for the modern "quick-action" railway train brake, as will appear by adjudications of the Courts therein.

An improvement thereon, also held by the Courts to be of high rank in the art, was shortly afterwards patented to George Westinghouse, Jr., one of your petitioners, by Letters Patent No. 376,837, dated January 24th, 1888, the title to which latter patent also became vested in your petitioners.

EIGHTH. In a suit brought by your petitioners against the New York Air Brake Company *et al.*, in the Second Circuit, for infringement, *inter alia*, of the Patent last above named, to wit, No. 376,837, the Court found it necessary to construe not only the said Patent No. 376,837, for infringement of which the suit was brought, but also the said earlier and pioneer Patent No. 360,070. This was done by His Honor Judge TOWNSEND, sitting as Circuit Judge at the final hearing of said cause, the same being known in the reports as No. 4977. Judge TOWNSEND's opinion is reported in 59 Fed. Rep. 581.

NINTH. Said cause No. 4977 having been taken by appeal to the U. S. Circuit Court of Appeals for the Second Circuit, was heard by the Honorable Circuit Judges WALLACE, LACOMBE and SHIPMAN, and

the unanimous opinion of the Court therein was rendered on or about October 15th, 1894, by His Honor Judge SHIPMAN.

In that Court, as in the Court below, it was found that the patent in suit, No. 376,837, was so intimately connected with the previous pioneer Patent No. 360,070 that to construe the former, it was necessary to first construe the latter.

The opinion of the Circuit Court of Appeals for the Second Circuit involving, *inter alia*, the proper construction of both these patents, is reported in 26 U. S. App. ; 11 C. C. A., 528; 63 Fed. Rep., 962. A copy thereof is hereunto annexed.

TENTH. Your petitioner The Westinghouse Air Brake Company, having in the meantime acquired the entire title to both said patents, brought another suit for a new infringement against the said The New York Air Brake Company *et al.* in the said Second Circuit. This new suit was based *inter alia*, as well on said Patent No. 360,070 as on said Patent 376,837. Motion was made for a preliminary injunction therein, which came on for hearing before his Honor Circuit Judge LACOMBE. After argument and consideration, the injunction was granted, as prayed for, under claims 1, 2 and 4 of said first or earlier Patent No. 360,070, as well as under claim 1 of said further Patent No. 376,837.

The opinion of his Honor Judge LACOMBE is reported in 65 Fed. Rep., 99, and being affirmed "*Per Curiam*" on appeal, as to Patent No. 360,070, a copy of Judge LACOMBE's opinion is hereunto annexed.

ELEVENTH. The defendants therein appealed to the Circuit Court of Appeals for the Second Circuit, and the appeal came on regularly for hearing before the Honorable Circuit Judges WALLACE and SHIPMAN and District Judge TOWNSEND. On or about May 28th, 1895, a "*Per Curiam*" decision was filed, *inter alia*, affirming the decision of Judge LACOMBE as to "the first, second and fourth claims of Patent No. 360,070." This decision is reported in 69 Fed. Rep., 715, and a copy thereof is hereunto annexed.

TWELFTH. That, as appears by the foregoing decisions and opinions, the Circuit Court of Appeals in the Second Circuit has adjudicated and declared, in one suit brought by your petitioners, that the second claim of your petitioner's Patent No. 360,070 is a valid claim, covering and protecting a legitimate and valuable sub-

ject matter, and the Circuit Court of Appeals for the Fourth Circuit, in another suit brought by your petitioners, has adjudged and declared that said second claim is invalid, and does not cover subject matter which can be lawfully claimed.

THIRTEENTH. That the subject matter of said second claim is of great value and importance to your petitioners, and is already involved in other suits and proceedings brought and pending in other causes unheard and undecided—and more particularly in a certain suit now pending in the U. S. Circuit Court for the Eastern District of Missouri, brought against the Lansburg Brake Company, *inter alia*, for the infringement of said claim 2 of said Patent No. 360,070.

FOURTEENTH. Your petitioners further show that said decisions or adjudications, in the Circuit Courts of Appeals for the Second and for the Fourth Judicial Circuit, are at variance or in conflict with each other, and that the errors of one or the other of them can only be authoritatively corrected in this Honorable Court.

Also that other of the matters of law so as aforesaid decided by the Circuit Court of Appeals for the Fourth Circuit are at variance with sundry of the decisions of this Honorable Court, as well as of other Circuit Courts of Appeal in other Circuits, and that any errors made therein can only be authoritatively corrected in this Honorable Court.

Your petitioners further allege that (as they are advised by their counsel and verily believe), as to all the matters so at variance, as well as to sundry and divers other matters, the said decision of the Circuit Court of Appeals of the Fourth Circuit contains manifest error of law, as well as of fact, material to the issues of the said cause.

FIFTEENTH. Your petitioners further represent that the matters as to which the Circuit Court of Appeals have adjudicated adversely to your petitioners, and more particularly the matters as to which said decision is in conflict with decisions made by other Circuit Courts of Appeal, and by this Court, are matters in which, if they are not corrected, the rights of your petitioners, as also the interests of the public, will suffer irreparable injury.

Your petitioners further represent that the irreparable injury to which they will be subjected by reason of an adverse, and, as your petitioners believe, erroneous decision by the Circuit Court of Appeals for the Fourth Circuit, is particularly apparent because the invention of the patent in suit, No. 360,070, is one which is used on upwards of 400,000 freight cars at the present time, and said freight cars are operated on all the railroads of the country, and may be found on every railroad from Maine to Florida, and from Boston to San Francisco. Such cars traverse every judicial district in the United States, and infringements upon the said Patent No. 360,070 are likely to occur, and have, in fact, occurred, as your petitioners believe, in every judicial district of the Circuit Courts of the United States, and it will be an irreparable and intolerable source of injury to your petitioners if their Patent No. 360,070, which, as they verily believe, covers and protects them in the exclusive enjoyment of an invention of the character described therein, which is universally used throughout the whole of the United States and in all judicial circuits thereof, should be rendered practically, or, at all events, to a very large extent, useless and inefficient for their protection; because whilst its validity has been sustained by the Circuit Court of Appeals for one Circuit, its validity has been denied by the Circuit Court of Appeals for another circuit.

Such a condition of conflicting decisions it is the proper province of this Honorable Court, as your petitioners are advised, to correct and obviate.

Assignments of Variance and Error.

First. As to the validity of claim 2 of the patent in suit, No. 360,070, as matter of law on the face of such claim, the decision of the Court of Appeals for the Fourth Circuit is in terms, and apparently in scope and effect, irreconcilably at variance with the holding of the U. S. Circuit Court of Appeals for the Second Circuit.

And herein, your petitioners submit the following extract from the opinion of the Court of Appeals for the Fourth Circuit, in the cases Nos. 131 and 134, now sought to be brought before your Honorable Court by writ of *certiorari :*

" We think that when claim 2 of 360,070, in its language de-
" scribing the action of that device, failed to describe any means by
" which the extreme traverse of the piston produced it, declaring
" merely that the piston ' by a further traverse, admits air directly

"from the main air pipe to the brake cylinder,' it was fatally "defective, claiming only a result which is public property and not "identifying the specific means (his own property) by which the "result is achieved" (Opinion, p. 19).

In the Court of Appeals in the Second Circuit, this claim 2 of Patent 360,070 was held to be valid.

SECOND. As matter of error herein, your petitioners submit that the said decision of the said Circuit Court of Appeals for the Fourth Circuit, that said claim 2 of Patent No. 360,070 is "fatally defective" in matter of form, or in the substance thereof, is not well founded in fact or in law.

THIRD. As further matter of error herein, your petitioners respectfully submit that manifest error was made by the said Circuit Court of Appeals for the Fourth Circuit, in its rulings as to the effect of the proceedings in and action of the U. S. Patent Office, and herein (Opinion, p. 17).

(1) That error was made in holding as matter of law or fact, without proof, that the said Patent Office "employs the best experts "in mechanics which it can secure in this and other countries."

(2) That error of fact was made in holding that the examinations made in the U. S. Patent Office, though "*ex parte* in form," are "nevertheless conducted under hot and skillful contestation in every "case of importance."

(3) That, possibly by these errors of fact, error of law was made wherein it was held by the said Court that in granting a later patent to Boyden, without notice of any kind, "that action by the office "was in effect a ruling that the Boyden device did not infringe "Westinghouse Quick-Action Patent No. 360,070."

(4) Further error was made in holding as matter of evidence that "that ruling [of the Patent Office] takes rank here as the "testimony of experts of the highest experience, skill and knowledge "in mechanics."

FOURTH. And as matter of error and variance herein, your petitioners respectfully represent that the force and meaning of the phrase "substantially as set forth," as explained and applied by the said Circuit Court of Appeals for the Fourth Circuit, is directly at variance with the decisions of this Court, and is in error as matter of law (Opinion, pp. 15, 16).

FIFTH. As further matter of error herein, and as a matter irreconcilably at variance with the ruling of the Circuit Court of Appeals in the First Circuit, your petitioners further submit that manifest error was made by the said Circuit Court of Appeals for the Fourth Circuit in holding as matter of law that *the mere erasure* from the original specification of a description of a proposed modification operates as a *disclaimer* of such modification.

And your petitioners respectfully represent to your Honorable Court that in the said decision or opinion of the said Circuit Court of Appeals for the Fourth Circuit, there are sundry and divers other errors manifest on the record material to the issues therein, but which cannot be made readily intelligible except by a comparatively full reference to the testimony and exhibits therein, with possibly the aid of an oral argument. And herein your petitioners would submit anew the assignments of error entered in case No. 134 (Cross-Appeal Rec., pp. 3–5), in connection with the cross-appeal, as also the following:

SIXTH. The Court erred in holding that defendant's valve 22 is an integral valve, or that complainant's patent is limited to a non-integral valve.

SEVENTH. The Court erred in passing at all on the question of an integral as distinguished from a non-integral valve—this, under the pleadings and proofs herein, presenting purely a *moot* case or question.

EIGHTH. The Court erred in holding that defendant's apparatus was not an infringement of claims 1, 2 and 4 of complainant's patent, and each of them.

NINTH. The Court erred in holding that Patent No. 217,838 had ever been used, or was capable of any practically beneficial commercial use, either alone or in connection with Patent No. 220,556, all the proofs being the other way.

TENTH. The Court erred in holding that Patent No. 220,556 ever made, or was capable of making, what is known in this case as an emergency stop—all the proofs being the other way.

ELEVENTH. The Court erred in holding that in Patent No.

220,556, the ordinary work of braking was performed by a partial traverse of the triple piston—all the proofs being to the contrary.

TWELFTH. The Court erred in not reversing the decree of the Court below in case No. 131, and in not affirming the decree of the Court below in case No. 134.

Finally, your petitioners aver that the present case is one in which it is proper for this Court to issue a writ of *certiorari* for the following reasons:

1. The first assignment of error relates to and involves a conflict of decisions by courts of last resort on a matter of law in identically the same question; that is to say:

Is claim 2 of the Westinghouse Patent "*fatally defective*," because it claims "*only a result*," as decided by the Circuit Court of Appeals for the *Fourth* Circuit, November 11th, 1895; or is it valid as held by the Circuit Court of Appeals for the *Second* Circuit, on May 28th, 1895?

2. Under the second assignment of error, traverse is made of the correctness of the decision in the Fourth Circuit, as affected by the form or phraseology of the claim.

3. The rulings made in the Fourth Circuit, as to practice and procedure in the Patent Office, are not only productive of irreparable injury to your petitioners, but unless reviewed and corrected, will operate to the irreparable injury of all inventors and patentees, and especially of those who are entitled to be called pioneers in the arts. If the grant of a *later* patent be a ruling by the Patent Office of non-infringement, and if such ruling be allowed to "take rank as "testimony in the case, of experts of the highest experience, skill "and knowledge in mechanics," the rights of the earlier pioneer patentees cannot be otherwise than irreparably injured thereby—and this under the third assignment of error.

4. Under the fourth assignment of error, it is submitted that the Court of Appeals in the Fourth Circuit have adopted a meaning or construction for the words "substantially as described," which is directly at variance with that established by the Supreme Court.

Also, that when dealing with a pioneer patent, Judge HUGHES "confines the inventor's rights to his own means," etc., he is directly and again at variance with the repeated rulings of the Supreme Court, both generally, and also specially in that no distinction is thus drawn between those "means" which are material and substantial, in the combination claimed as such, and such other "means" as are *neither* material nor substantial, to the combination claimed, as such.

5. And under the fifth assignment of error, the decisions in the First and Fourth Circuits are irreconcilably at variance.

And this also involves a question of practice which can only be settled by the Supreme Court, and which, being an important one, not only to your petitioners, but to inventors and patentees generally, ought to be so settled.

Other assignments of error, though material and believed to be well founded, can best be made intelligible by the use of the exhibits and by oral argument.

A certified copy of the entire record of the said recited cases in the Circuit Court of Appeals for the Fourth Circuit, is filed herewith as part of this application.

Whereupon your petitioners respectfully pray that this Honorable Court will be pleased to grant a writ of *certiorari*, requiring the first above-entitled cases, Nos. 131 and 134, in the U. S. Circuit Court of Appeals for the Fourth Judicial Circuit, to be certified to this Honorable Court for its review and determination.

GEORGE WESTINGHOUSE, JR.
THE WESTINGHOUSE AIR BRAKE CO.
By GEORGE WESTINGHOUSE, JR., Pres.

FREDERIC H. BETTS,
GEORGE H. CHRISTY,
Of Counsel for Petitioners.

BLEED THROUGH POOR COPY

In the Circuit Court of the United States.

FOR THE DISTRICT OF MARYLAND.

George Westinghouse, Jr., and The Westinghouse Air Brake Company vs. The Boyden Power Brake Company.	In Equity.

(Decided March 11, 1895.)

J. Snowden Bell, Bernard Carter, George H. Christy and *Frederic H. Betts*, for complainants.

Barton & Wilmer, Cowen & Cross, Hector T. Fenton and *Lysander Hill*, for defendant.

This is a bill in equity, in usual form, charging the defendant with infringing the Westinghouse Patent No. 360,070, dated March 29, 1887, for a fluid-pressure automatic brake mechanism.

The claims alleged to have been infringed by the defendant are claims 1, 2 and 4, which are as follows:

"1. In a brake mechanism, the combination of a main air-pipe, an auxiliary-reservoir, a brake-cylinder, a triple-valve and an auxiliary valve device, actuated by the piston of the triple-valve and independent of the main valve thereof, for admitting air in the application of the brake directly from the main air-pipe to the brake-cylinder, substantially as set forth.

"2. In a brake mechanism, the combination of a main air-pipe, an auxiliary-reservoir, a brake-cylinder and a triple-valve having a piston whose preliminary traverse admits air from the auxiliary-reservoir to the brake-cylinder, and which by a further traverse admits air directly from the main air-pipe to the brake-cylinder, substantially as set forth.

"4. The combination, in a triple-valve device, of a case or chest, a piston fixed upon a stem and working in a chamber therein, a valve moving with the piston-stem and governing ports and passages in the case leading to connections with an auxiliary-reservoir and a brake-cylinder and to the atmosphere, respectively, and an auxiliary valve actuated by the piston-stem and controlling communication between passages leading to connections with a main air-pipe and with the brake-cylinder, respectively, substantially as set forth."

The only defense now urged by the defendant is non-infringement.

The history of the pioneer invention of George Westinghouse, Jr., in fluid-pressure brakes, by means of which the brakes of a train of railroad cars can be operated by air pressure controlled by the engineer of the train, and the history of the successive steps and inventions by which he has devised mechanisms adapted to apply that power so as to act automatically on each car, and the scope and fundamental importance of his later inventions by which he has accelerated, in an astonishing degree, the quickness with which the brakes can be applied, almost simultaneously, on each car of a long train consisting of as many as fifty freight cars, has been carefully and fully stated by Judge Townsend, who delivered the opinion in the case of Westinghouse vs. New York Air Brake Co. (59 Fed. Rep., 581), and by Judge Shipman in the same case on appeal (63 Fed. Rep., 962), and in the opinion of Judge Lacombe, filed December 27, 1894, in a case between the same parties in the United States Circuit Court for the Southern District of New York.

The patent now in suit, No. 360,070, March 29, 1887, is the first of the Westinghouse patents in which he describes an additional function, engrafted upon his automatic air-brake, which is intended to be used only in cases of unusual emergency, and which is intended to meet the difficulties of applying air-brakes quickly on long trains. The purpose of the device was to increase the quickness of the serial action

of the automatic brake mechanism on each successive car, by making the triple-valve device of each brake mechanism set in operation the valves on the car immediately in its rear, and at the same time to make use of the train-pipe air, vented for this purpose from the train-pipe at each triple-valve, so as to add its power to the power applied from the auxiliary-reservoir of each car.

The result which Westinghouse was seeking in the new device, described in Patent No. 360,070, was first, and principally, to vent the train-pipe at each car, so as to quicken the serial action of the brakes from car to car; and, secondarily, to utilize the vented air and not waste its power.

Westinghouse discovered that he could accomplish this result by so constructing the ordinary triple-valve of his automatic mechanism that, when in an emergency, the engineer, by widely opening his engineer's valve, and thereby causing a sudden and unusual release of pressure in the train-pipe, could cause the piston of the triple-valve to make an unusual and further traverse and thereby actuate a valve, which opened a port by which the train-pipe air was admitted suddenly and directly into the brake-cylinder, without passing through the auxiliary-reservoir.

This sudden release of air from the train-pipe vented that pipe at the first car, and that venting, in like manner, released the pressure in the train-pipe at the valve of the next car, and so on from car to car with almost instantaneous rapidity.

It is shown that this device, as first constructed, was not entirely successful. It applied the brakes with greatly increased serial rapidity, as compared with any former device, and with much greater power, but not so quickly but that the rear cars impinged against the forward ones with destructive shocks.

The reason for this appears to have been that the operation of venting was not carried far enough, because the port opened by the auxiliary valve was not of sufficient size and did not release the full volume of train-pipe air sud-

denly enough to vent it sufficiently. This defect was remedied by an improved mechanism, devised by Westinghouse and described in his Patent No. 376,837, January 24, 1888.

The success of this improved device has demonstrated that the invention, by which the further traverse of the triple-valve piston, beyond the extent of the traverse required for the ordinary application of the brakes, is made to admit a large volume of train-pipe air directly to the brake-cylinder, was one of great importance.

The proofs show that a quick-action automatic brake, which would give the results which this brake has accomplished, was eagerly sought after by inventors and car builders, and all had failed, until Westinghouse discovered that it could be done by this mode of operation.

In the cases above referred to, in which this Patent, No. 360,070, and the improvement on it, No. 376,837, were discussed with reference to the state of the art and the scope of the invention therein disclosed, these were held to be patents of a fundamental pioneer class, describing an invention of primary importance.

In those cases, the defendants, who were charged with infringing, were using a separate and independent valve to open the port to the train-pipe, and the question was whether or not Westinghouse was restricted to the form of independent valve and the precise mode of actuating it set out in his patent. It was held that he was entitled to a liberal construction of his claims, and that, in respect to the emergency valve, the form of his device was not of the essence of his invention.

In the Boyden mechanism, which is alleged in this case to infringe, I have not been able to satisfy myself that Boyden makes use of an auxiliary valve, in the sense in which that term is employed in the specification and in some of the claims of the Patent No. 360,070, now in suit.

It appears from the specification of Patent No. 360,070, that what Westinghouse meant by the auxiliary valve, which

is made one of the elements of the combination in the first and fourth claims, is such a valve as he has described in his specification, and which is independent of and performs none of the functions of the main valve of the ordinary triple-valve device, and I am not satisfied, notwithstanding the very positive testimony of the complainants' experts, that the poppet-valve 22 of the Boyden mechanism is such a valve; for Boyden's poppet-valve 22 does, as I understand its operation, to some extent, perform the functions of a main valve of the triple-valve, as well as the function of Westinghouse's auxiliary quick-action or emergency valve.

It is probably true that, in the Boyden mechanism, the stem valve *i*, *k*, *j*, which I take to be the equivalent of the sensitive graduating valve shown in the Westinghouse Patent No. 220,556, October 14, 1879, is so constructed that it may do, and probably in most cases does do, the work of ordinary braking; that is to say, that, by two or three successive applications of pressure through that smaller and more sensitive valve, the brake-cylinder is filled and the main valve 22 becomes non-essential, or, if lifted off its seat, is moved very gently; but valve 22 will, if the engineer uses his brake valve carefully, do the work of a main valve, as is demonstrated, I think, by the experiments in which the sensitive graduating valve *i*, *k*, *j*, was plugged up. So I take it that defendant's valve *i*, *k*, *j*, must be held to be the sensitive graduating valve usual in triple-valve devices since the Westinghouse Patent No. 220,556; and the defendant's valve 22 must be considered to be the main valve, and that in defendant's mechanism he has been able, by an ingenious arrangement, restricting the admission of auxiliary-reservoir air to the triple-valve chamber, to cause the main valve to do both main-valve work, when needed, and to do quick-action work, when needed.

As, by the explicit terms of claims 1 and 4, Westinghouse has restricted himself, as to those claims, to an auxiliary valve,

independent of the triple-valve, I hold that the defendant does not infringe those claims.

CLAIM 2.

Claim 2 reads as follows :

"2. In a brake mechanism, the combination of a main air-pipe, an auxiliary-reservoir, a brake-cylinder, and a triple-valve having a piston, whose preliminary traverse admits air, from the auxiliary-reservoir to the brake-cylinder, and which by a further traverse, admits air directly from the main air-pipe to the brake-cylinder, substantially as set forth."

The first three elements of this claim are the usual mechanism of an automatic air-brake; the remaining element, which was the only novel one at the date of the patent, is a triple-valve having a piston which, by two distinct movements, performs two distinct functions, the first, its preliminary traverse by which it admits air from the auxiliary-reservoir to the brake-cylinder, which is the ordinary effect of the usual movement of the triple-valve piston, and the second, its further traverse, which is a new and distinct use, admitting air directly from the main air-pipe to the brake-cylinder, resulting in venting the main air-pipe and in producing the quick-action.

Now this, as I understand it, was the invention which Westinghouse brought to light. He discovered, and by experiment demonstrated, that, by a further traverse of the triple piston, train-pipe air could be vented from the train-pipe and that it would give two very important results, namely; first, quickening of the action of the brakes from the forward to the rear cars so that the application of the brakes became almost instantaneous on all the cars, and, second, utilizing the vented air for direct action in the brake-cylinder. Now, although quick-action emergency brakes were being sought for, no one before Westinghouse had accomplished this result and the means by which he accomplished it were entirely novel. Indeed, upon

first impression, it is paradoxical and startling to find that, when a sudden, quick and powerful application of brakes is needed, in the face of impending danger, it is to be obtained by a sudden large release of the pressure in the train-pipe, to the extent of fifteen or twenty pounds below that in the auxiliary-reservoir, and that, by using this low-pressure air to operate the brake-cylinder, instead of the air under greater pressure stored in the auxiliary-reservoir, this remarkably effective application of the brakes is obtained. In the domain of quick-action brakes, this device would seem to belong to that class of pioneer inventions, the patents for which are to be construed so as to be co-extensive with the real invention, if the language of the claim will permit it.

It is shown that Westinghouse was the first who used a further traverse of the triple-valve piston to perform the operation required to vent the train-pipe into the brake-cylinder to effect quick-action. The result was new and the means were new. His claim 2 is broad enough in language to cover every device in which that is done by the further traverse admitting air directly from the train-pipe to the brake-cylinder, substantially by the means described in the specification; that is, by the further traverse actuating a valve which so admits the train-pipe air.

The result accomplished by defendant's mechanism is identical with that of Westinghouse, and the means, by which the mechanism is actuated, so alike, that, in its published trade catalogue, defendant claims that cars fitted with its valves can be used on the same trains with the Westinghouse quick-action brake, because the engineer, in applying or releasing the air-pressure, may treat them as identical; the same functional operations of the valves, and the same results, being obtained from the same changes in the engineer's brake valve, so that there is strong *prima facie* reason to suppose that Boyden's way of using the same release of pressure to vent the train-pipe and to actuate the valves, which produces identical results, may be Westinghouse's way.

In mechanisms actuated by air under pressure, the trans-

mission of power is not visible to the senses as plainly as when it is done by cranks and levers, and, being transmitted by an invisible agency in all directions in which the air can escape, the functions of the instrumentalities by which it operates are more important than their forms, and, in judging of an infringement, we are to direct our minds rather to functional equivalents than mechanical equivalents.

The use by Boyden of a central opening through the triple-valve piston, to admit train-pipe air to the triple-valve chamber, was not new, nor the use of a poppet-valve for the main valve of the triple, both of these constructions having been shown in the Westinghouse Patent No. 141,685, August 12, 1873, and in others of his patents. So that there is nothing in the Boyden device not before exhibited in some one of the Westinghouse Patents; except that he has been able to cause one of the valves of the triple (valve 22), at one stage of the application of brakes, to perform ordinary service work, and, at another, to do quick-action work. This Boyden does by an ingenious construction not before used, by which he restricts the passage of auxiliary-reservoir air into the triple-valve chamber, so that, when the further traverse of the piston suddenly unseats the poppet-valve 22, the port opened by it to the brake-cylinder is so large and the supply of auxiliary reservoir air through the restricted passage so feeble, that the train-pipe air raises its check-valve and vents itself into that chamber, and thence through the large port to the brake-cylinder. For the mechanism embodying this ingenious contrivance, by which the poppet-valve 22 is made capable of doing ordinary service work by a careful, intermittent, slow release of pressure by the engineer, and quick-action work by a quick, sudden release, patents were granted to Boyden (No. 481,135, August 16, 1892, and No. 481,136, August 16, 1892); but, if this construction contains the underlying invention of the patent in suit, which was granted March 29, 1887, Boyden cannot make use of his improvement during the life of that patent.

It is true that, in searching for some device which would give quick-action, Westinghouse had, before the date of the patent in suit, conceived the idea that it might be accomplished by venting the train-pipe at intervals along the train. He had tried having two or three vents, at intervals in the length of the train, controlled by electrical apparatus, and also had tried relief-valves placed in the pipe-coupling of each car, which would open to the atmosphere and vent the train-pipe quickly, in case of accident or other sudden release of pressure in the forward part of the train. This was shown in the Westinghouse Patent No. 217,838, July 22, 1879, but neither of these attempts were successfully applied, and they did not solve the problem of quick-action.

The problem was not solved; indeed, the first step in the direction of solving it does not appear to have been taken until the experiments which led to the Westinghouse Patent now in suit. The substance of the method then devised is the use of the sudden further traverse of the triple-valve piston to open a valve in a manner different from the valve opening made by the preliminary traverse for service braking, thereby admitting train-pipe air to the brake-cylinder without its passing through the auxiliary reservoir.

In the Westinghouse apparatus, the further traverse of the triple-valve piston causes it to impinge against an additional, separate valve which admits the train-pipe air. In Boyden's apparatus, used by defendant, the further traverse pulls the poppet-valve 22, which Boyden substituted for the ordinary main valve of the triple, suddenly off its seat, thereby, in the manner before mentioned, causing the train-pipe air to raise the check-valve and flow with volume, through the triple-valve chamber, direct to the brake-cylinder. The device in Boyden's apparatus, by which the difference of pressures in the triple-valve chamber, between auxiliary-reservoir air and the train-pipe air, is produced and used, is ingenious and admirable: but the result obtained is just the same as when, in the

Westinghouse apparatus, the auxiliary valve is unseated, and the means used are, in my judgment, functionally equivalent.

Under the ruling of Morley Machine Co. vs. Lancaster, 129 U. S., 263, and of the many cases cited in the opinion delivered in that case, the rights of a pioneer inventor are infringed by one who accomplishes the same result by means which, although never used for that purpose before, are mechanical equivalents for the means used by the inventor, under a liberal construction of his patent. It was said in that case by Mr. Justice BLATCHFORD (p. 273):

"Where an invention is one of a primary character and the mechanical functions performed by the machine are, as a whole, entirely new, all subsequent machines which employ substantially the same means to accomplish the same result are infringements, although the subsequent machine may contain improvements in the separate mechanisms which go to make up the machine."

In McCormick vs. Talcot, 20 How., 402, the controversy arose over a device which McCormick had added to his reaper called a divider, intended to separate the standing grain to be left from that which is to be cut. The Court said:

"If he be the original inventor of the device or machine called the divider, he will have the right to treat as infringers all who make dividers operating on the same principle and performing the same functions by analogous means or equivalent combinations, even though the infringing machine be an improvement of the original and patentable as such."

In Machine Co. vs. Murphy, 97 U. S., 120–125, it was said:

"Nor is it safe to give much heed to the fact that the corresponding device in two machines, organized to accomplish the same result, is different in shape or form the one from the other, as it is necessary in every such investigation to look at the mode of operation or the way the device works, and at the result, as well as at the means, by which the result is attained."

The language of the Supreme Court in Consolidated Valve Co. vs. Crosby Valve Co., 113 U. S., 157–171, is applicable.

"The prior structures never effected the kind of result attained by Richardson's apparatus because they lacked the thing which gave success. * * * Taught by Richardson, and by the use of his apparatus, it is not difficult for skilled mechanics to take prior structures and so arrange and use them as to produce more or less of the beneficial results first made known by Richardson."

It is true that a patentee can claim nothing beyond the scope of his patent (Keystone Bridge Co. vs. Phœnix Iron Co., 95 U. S., 274), but the scope and meaning of a broad claim in the patent can only be interpreted by an understanding of the real scope of the invention itself.

If the Westinghouse Patent now in suit is for an invention of a primary character, and if the gist of that invention is the use of the further traverse of the triple-valve piston to open a valve which admits air directly from the train-pipe to the brake-cylinder, with the result that the train-pipe is vented and the train-pipe air utilized, then it appears to me that the defendant cannot exculpate itself from the charge of infringment by the fact that, in its device, the train-pipe air is admitted through the triple-valve chamber and not through a by-passage, nor by the fact that in its device the further traverse of the piston opens the main valve in a special manner, which produces the same result, but does not make use of a separate auxiliary valve ; provided, Westinghouse has not by the explicit terms of his claim 2 restricted himself to the use of an auxiliary valve.

I do not think Westinghouse has so restricted himself in claim 2, although he does appear to have done so in claims 1 and 4.

There is, without question, some difficulty and embarrassment in the broad construction of claim 2, growing out of the proceedings in the Patent Office, as shown by the

file wrapper and contents ; but, considering what was the real invention, I am not of the opinion that the legal effect of those proceedings is to restrict claim 2 to a device containing a separate auxiliary valve.

From the contents of the file wrapper, it appears that, as the application was prepared, the first claim of Patent No. 360,070 differed from that which now appears in the patent as granted.

The claim 1 first proposed was

"1. In a brake mechanism, the combination of a main air-pipe, an auxiliary-reservoir, a brake-cylinder, a triple-valve provided with a device for admitting air directly from the main air-pipe to the brake-cylinder, substantially as set forth."

It was objected by the Patent Office Examiner that this claim and also claim 2 were anticipated by Patent No. 280,285, to G. A. Boyden, June 26, 1883, and the Examiner requested that a working model of the triple-valve should be furnished.

Boyden's Patent of 1883, No. 280,285, was a form of triple-valve mechanism, intended for use with Westinghouse's automatic air-brake, the object of which was to provide for replenishing the auxiliary-reservoir of each car when the pressure therein had been lessened by leakage and while the brakes remained applied. This was done by the engineer causing, not a release, but a slight increase of the pressure in the train-pipe air, which, acting upon a check-valve in the centre of the triple-valve piston, by a peculiar arrangement of the valves, caused train-pipe air to pass together with auxiliary-reservoir air to the brake-cylinder. The object, function and result of whatever was new and patentable in this Boyden device was altogether different from the object, function and result of the Westinghouse device in Patent No. 360,070, and there seems to be no analogy or comparison which can be made between them.

It is true that the "always-open one-way passage" in the Boyden Patent which, when the check-valve was raised,

allowed train-pipe air to reach the brake-cylinder, was, in the language of the cancelled claim 1 of No. 360,070, " a device for admitting air directly from the main air-pipe to the brake-cylinder," and there were other devices, used by Westinghouse himself, which this wording would include; and the claim was, therefore, justly open to the criticism of the Patent Examiner; but there was no similarity in the means by which the two devices were actuated, no similarity in the object to be accomplished, and no similarity in the mechanical principle of operation. It was simply a fact that there did exist in the Boyden device a passage for train-pipe air direct to the brake-cylinder, which the engineer could cause to open by a slight increase of train-pipe pressure; but there was no hint or suggestion of the important discovery how that fact could be utilized to accomplish the entirely new function necessary to create a quick-action brake, when, in an emergency, quick-action was needed; and how, when quick-action was not needed, it should not interfere with ordinary graduation and service stops. This Boyden device was not in the direction of quick-action, but its opposite.

While, therefore, it was proper that Westinghouse's original claim 1 should be corrected, so as to express more definitely his real invention, this was not because the Boyden Patent, in any manner whatever, anticipated that invention, or suggested it in any of its functions.

For the same reason, there was then inserted in the specification of the Westinghouse Patent No. 360,070, this clause:

" I am aware that a construction, in which 'an always-open one-way passage' from the main air-pipe to the brake-cylinder is uncovered by the piston of the triple-valve, simultaneously with the opening of the passage from the auxiliary-reservoir to the brake-cylinder, has been heretofore proposed, and such construction, which involves an operation different from that of my invention, I, therefore, hereby disclaim."

In the Boyden infringing device now used by the defendant, the passage from the main air-pipe to the brake-cylinder is not "uncovered by the piston of the triple-valve, simultaneously with the opening of the passage from the auxiliary-reservoir to the brake-cylinder"; if it was, the defendant's mechanism would be always a quick-action brake and never anything else; but, on the contrary, in the infringing device, the passage is not opened until there has been a sudden further traverse of the piston, which then brings it into operation for the distinct purpose of quick action. The statement of the so-called disclaimer is strictly true, that the construction of the Boyden 1883 Patent "involves an operation different from" the Westinghouse invention, and the so-called disclaimer in reality disclaims nothing which has relation to the Westinghouse quick-action invention.

The disclaimer was substituted in the place of the following, which had been in the specification, and was cancelled:

"Further, while in the specific construction described and shown, the function of admitting air from the main pipe is performed by a valve separate from that which effects the preliminary admission of reservoir-pressure to the cylinder, a modification, in which the same office is performed by a valve integral with the main valve and formed by an extension thereof, would be included in and embody the essential operative features of my invention."

The testimony tends to prove that this clause of the specification was taken out because the Examiner objected that no such form of triple-valve was illustrated in the drawings. For whatever reason it may have been cancelled, it is not a necessary result that the patentee is precluded from claiming that his patent covers other forms of valve, integral with the main valve, if such is his legal right, when his invention, as disclosed in his patent, is found to be a broad one, and if he is not restricted by his claims and if he has done nothing to impair his right to be protected in his whole inven-

tion. The effort should be to preserve, rather than to forfeit, the inventor's rights.

> Keystone Manufacturing Co. vs. Adams, 151 U. S., 144.

The object and scope of the invention, and the means employed to effect his object, are thus stated by Westinghouse in the specification of his patent in suit:

"The object of my invention, is to enable the application of brake-shoes to car wheels by fluid pressure to be effected with greater rapidity and effectiveness than heretofore, more particularly in trains of considerable length, as well as to economize compressed air in the operation of braking by utilizing in the brake-cylinders the greater portion of the volume of air which in former practice was directly discharged into the atmosphere. To this end, my invention, generally stated, consists in a novel combination of a brake-pipe, an auxiliary-reservoir, a brake-cylinder and a triple-valve device governing, primarily, communication between the auxiliary-reservoir and the brake-cylinder, and, secondarily, communication directly from the brake-pipe to the brake-cylinder."

This language exactly describes the infringing mechanism of the defendant.

The amendments made to meet the objections of the patent examiner are not to be construed to disclaim the patentee's actual invention, if such construction can be avoided without doing violence to the obvious meaning of the language.

> Lake Shore Railway Co. vs. Car Brake Co., 110 U. S., 229–236.
>
> Reese Button Hole Machine Co. vs. Globe Button Hole Co., 61 Fed. Rep., 958.

It has been urged that the invention disclosed by the patent in suit is not of a meritorious character, because, in the form in which it is there embodied, or at least in the first mechanism manufactured by Westinghouse, it failed of success in some essentials, and was immediately improved by Westinghouse, in a manner which was the subject of a subsequent patent, before it was successful in the use for which

it was intended. The defect developed by experimental test, and which Westinghouse in a few months remedied, was that the opening uncovered by the auxiliary valve was not sufficiently large to suddenly release the full volume of train-pipe air. This was not a defect inherent in the device (59 Fed. Rep., 581–591).

There were structural objections to making that opening large; but, when made larger, the device answered the purpose for which it was intended. It was thought, however, better to remedy the difficulty by adding an auxiliary piston, as well as an auxiliary valve, and it was in that line that Westinghouse carried his further improvements, and he has adopted that form, as the best to be manufactured for general use.

This defect in the patent in suit was not radical, and was only one of those defects common in the first forms of many pioneer inventions, which usually have to be improved upon before they attain commercial success.

It is further urged that in a doubtful case the scale should be turned by the fact that, subsequent to the date of the patent in suit, indeed more than two years after the institution of this suit, Patents Nos. 481,135 and 481,136, August 16, 1892, were granted to Boyden for the mechanism now used by the defendant.

Boyden was entitled to patents for whatever was a patentable novelty in the devices by which he was able to make his valve 22 answer for both service and quick-action work, in connection with the restricted passage B, and for any other patentable novelty in the forms of his mechanism. The widely different forms in which he has illustrated his devices in the two above-mentioned patents show that, taking what Westinghouse had discovered and demonstrated to be the underlying principle of a quick-action brake, a skillful and inventive mechanic can devise many forms for applying it.

But, in his specification of Patent No. 481,135, Boyden alleges that his device differs essentially from Westinghouse's Patent No. 360,070, and involves a new mode of

operation. The question whether it does or not, was the very question pending in this suit, and, so far as the Examiner passed upon it, in allowing the specification to stand, he did so upon the *ex parte* application of Boyden and unassisted by testimony as to the state of the art at the date of the Westinghouse Patent, without testimony as to the scope of the Westinghouse quick-action invention and its great importance and merit; and, therefore, without the opportunity of judging whether or not it was a pioneer invention of a fundamental character, entitled to a construction coextensive with the invention, or was simply a patent for an improvement in a known art, to be restricted to the form of the device shown in the model and illustrations.

The determination of that question is the starting point in the consideration of the controversy and, in my judgment, the fact that Westinghouse was the first discoverer of the vital underlying invention, should turn the scale in his favor.

The complainants are entitled to a decree for an injunction and account, with a reference to a Master in the usual form.

United States Circuit Court of Appeals

FOR THE SECOND CIRCUIT.

THE WESTINGHOUSE AIR BRAKE COMPANY vs. THE NEW YORK AIR BRAKE COMPANY ET AL.	Nos. 4976 and 5315.
GEORGE WESTINGHOUSE, JR., and THE WESTINGHOUSE AIR BRAKE COMPANY vs. THE NEW YORK AIR BRAKE COMPANY ET AL.	No. 4977.

SHIPMAN, C. J.:

The various appeals in these three cases are from decrees of the Circuit Court for the Southern District of New York, upon three bills in equity for the alleged infringement of Letters Patent. No. 4977 was founded upon Letters Patent No. 376,837, dated January 24, 1888, and Letters Patent No. 172,064, dated February 11, 1876, each issued to George Westinghouse, Jr. The Circuit Court decreed that the defendants should

be enjoined against their infringement of the first, second and third claims of No. 376,837, and that the bill should be dismissed as to No. 172,064. No. 5315 was founded upon Letters Patent No. 448,827 to George Westinghouse, Jr., dated March 24, 1891. The Circuit Court decreed that the defendants should be enjoined against the infringement of the first and second claims of this patent.

No. 4976 was founded upon Letters Patent No. 393,784, dated December 4, 1888, to Harvey S. Park, and No. 222,803, dated December 23d, 1879, to George Westinghouse, Jr. The Circuit Court dismissed the bill as to No. 393,784, and decreed that an injunction should issue against the infringement by the defendants of the second, third and fourth claims of No. 222,803. The complainants and defendants have respectively appealed from the decrees which were respectively adverse to them.

These patents are for improvements in railroad brakes by fluid pressure, and will be better understood if they are considered in the order of their relation to each other, rather than as they are grouped in the bills in equity, and therefore Nos. 376,837 and 448,827, which was originally applied for in the application which resulted in No. 376,837, naturally take precedence.

It is necessary to give the history of the development by the patentee of the automatic "quick-action" air-brake system, because the construction of the important claims of the two patents now under consideration and of the patent to Park, No. 393,784, depends to a great degree upon a knowledge of this history, which was accurately condensed by Judge TOWNSEND, as follows:

"The first practical air brake is known as the 'plain brake,' and is described in Patent No. 88,929, granted to George Westinghouse, Jr., April 13, 1869.

"It consisted of a pump, operated by steam from the locomotive boiler, which compressed air into a reservoir located under the locomotive cab, which reservoir

communicated by a pipe with a cock or valve in said cab called the 'engineer's valve,' which was so located as to be readily manipulated by the engineer.

"From this valve a pipe extended back under the tender and was connected to a similar pipe under the entire length of the first car by a flexible hose. Each of the succeeding cars had a similar pipe similarly connected. This pipe was called the 'train pipe.' From the train pipe of each car a branch pipe communicated with the forward end of a cylinder called the 'brake cylinder.' This cylinder was provided with a piston, the stem of which was connected with the brake levers on the car. When the engineer wished to apply the brakes, he opened the engineer's valve and the compressed air from the main reservoir flowed back through the train pipe and branch pipes into the brake cylinder on each car, pushing the pistons backward, causing the piston stems to operate the brake levers and force the brake shoes against the wheels.

"When he wished to release the brakes, he so shifted the valve as to shut off the flow of compressed air from the main reservoir, and to open a port or vent leading from the train pipe to the open air. Thereupon the compressed air in the brake cylinders escaped into the open air, the pressure of the pistons was removed and the pistons were forced forward again by means of springs, thus moving the brake shoes away from the wheels.

"The validity of this patent was sustained in Westinghouse vs. Gardner & Ransom Air Brake Company (9 O. G., 538).

"The operation of this plain brake was open to certain objections. It was too slow, and was attended by danger of collision in case one part of the train became detached from the other part.

"The brake next to be considered is known as the 'automatic brake,' which appears to have been patented by George Westinghouse, Jr., about 1872 or 1873.

" It embodied the addition of an auxiliary reservoir and a triple-valve device to each car. Each reservoir was of sufficient capacity to operate its brakes once, thus to provide for automatic action in case of accident. The triple-valve device was located at the junction of connections between pipes leading to the train pipe, the brake cylinder and the auxiliary reservoir. In addition to these three ports, there was a fourth port leading to the open air.

" The operation of this brake was radically different from that of the 'plain brake.' In the former, the compressed air was stored in the main reservoir until required for the application of brakes. In the latter, the main and auxiliary reservoirs and train pipe were always charged with compressed air at working pressure, to prevent the application of the brakes. When the engineer wished to apply the automatic brake, he shifted the engineer's valve so as to cut off the flow of compressed air from the main reservoir and open a port from the train pipe to the open air. The effect of this was to reduce the air pressure in the train pipe, and cause a back pressure from each auxiliary reservoir through the triple valve, which shifted it so as to close the port from the branch pipe to the train pipe, and stop the escape of air from the auxiliary reservoir, to close the port leading from the brake cylinder to the open air, and to open the port leading from the auxiliary reservoir, and connect it with the port leading to the brake cylinder. Thereupon the compressed air in the auxiliary reservoir flowed into the brake cylinder and applied the brakes.

" It will thus be seen that, while the former system was operated by pressure from the main reservoir, the latter was operated by withdrawal of pressure. The result was automatic action in case of accidents, whereby air was caused to escape from the train pipe, as by bursting of hose or the train breaking in two. In such cases the release of pressure operated the triple valve, and automatically applied the brakes.

" It is necessary here to consider 'train-brake graduation' or 'service stops,' as distinguished from 'emergency stops.' While for the latter it may be necessary to admit to the brake cylinder the full pressure of compressed air, say seventy or eighty pounds, yet where it is desired merely to slow up without stopping, it may be necessary to admit only, say, ten or twenty pounds, graduating the amount of flow according to the character of service desired. It is important to bear this distinction in mind, because the appliances hereafter to be considered have been so devised as to provide therefor, and that such graduation shall be under the control of the engineer.

" The chief objection to this automatic brake lay in the fact that it was not capable of successful operation on long trains of freight cars. The time consumed by the progressive operation of the brakes between the grip on the first and last car allowed of so much slack motion between them as to cause violent shocks.

" This automatic brake was publicly tested near Burlington, Iowa, in 1886.

" The growing importance of the subject of automatic freight graduation, the inadequacy of existing systems to protect the lives of railroad employees, and the disastrous results therefrom, had become so evident that, in 1885, the Railway Master Car Builders' Association arranged for series of experiments, known as the 'Burlington trials.'

" The Westinghouse Company and several other companies engaged in the manufacture of brake apparatus, competed at these trials.

" None of the competitors succeeded in stopping long trains of freight cars without violent and disastrous shocks.

" In 1887 the trials were renewed. There were five competing parties, including one of the leading experts for the defendants, and the complainant company. The latter then presented an improved apparatus, covered

by Patent No. 360,070, granted to George Westinghouse, Jr., March 29, 1887.

"The report of the committee of the Car Builders' Association shows that they considered 'the field for improvement open as wide as in 1886,' and concluded that air brakes actuated by electricity were the only ones likely to be capable of successful operation on long trains of freight cars. The improved Westinghouse apparatus, while it reduced the length of time between the application of the first and last brakes, produced greater shocks than did the automatic apparatus of the preceding year.

"In this condition of affairs, George Westinghouse, Jr., set himself to work to obviate these difficulties. Upon the conclusion of the 1887 trials, he renewed his investigations and experiments, and, by certain changes and improvements in the old apparatus and the introduction of new elements, he succeeded, in the latter part of the year 1887, in constructing a quick-action automatic brake, capable of being successfully applied to a train of fifty freight cars, and operative under all conditions of practical railway service.

"On October 1st, 1887, he applied for a patent for this apparatus, and, on January 24th, 1888, the patent was granted. Said Patent, No. 376,837, is the first of the patents in suit.

"Before proceeding to consider in detail the claims of this patent, it should be stated that the following were among the requirements for the practical operation of air brakes:

"1. The regulation of the force to be applied to the brake-shoes so as to secure all necessary graduations, from the mere slackening of speed to the service stop, and from the service stop to the emergency stop.

"2. The automatic operation of the brakes in case of accident.

"3. The practically simultaneous operation of the brakes on each car so that, in long trains of freight cars, shocks might be avoided.

"4. The control of all these operations by the engineer.

"5. Certainty of operation under all conditions."

The automatic brake system constructed in general accordance with the invention described in No. 376,837 complies with all these essential conditions. It was unquestionably the first system which practically solved the problem of immediate stoppage of a long freight train in time of danger, in connection with and supplemental to "train brake graduation," and so promptly was its success recognized that 125,000 of this kind of brakes were bought and used by the railroad companies of this country within a period of little more than three years. It is, therefore, important to understand the nature of the improvement which created success.

The promptness with which an automatic air brake system could be made effectual, depended upon the promptness with which air pressure in the train-pipe could be reduced and the equalization of pressure could be changed. Before the series of inventions originated by the Burlington trials, this reduction had been effected in passenger trains of ordinary length by "venting" the train-pipe or opening a port from the train-pipe to the open air, which was initiated by a turn of the engineer's valve on the locomotive. Westinghouse, in his attempt to create efficient and immediate service upon each car of a long train, enlarged the venting system, so that, when the reduction of train-pipe pressure had commenced by the turn of the engineer's valve, the triple valve under each car should also vent the train-pipe of that car. Each car, therefore, contained its own venting mechanism, and, as the mechanism did its work upon its own car, it hastened the work upon the car next in the rear. Westinghouse also sought to save, and did save, power, by compelling the compressed air thus vented to pass into the brake cylinder instead of into the open air. But sudden and large reduction of pressure is only to be used in a case of emergency, and, therefore, means for such re-

duction must be made supplementary to the means for the ordinary service of the brakes, so that ordinary and extraordinary use of the brakes can each be made available as necessity arises.

The method in No. 360,070 was to make the ordinary range of motion of the triple-valve piston, which was produced by a reduction of train-pipe pressure of a few pounds, do the ordinary work of "braking" a train, and to make an extraordinary range of motion throughout the entire length of its capacity for travel, which was produced by a reduction of fifteen or twenty pounds, do the extraordinary work which gave to the brake the name of "quick-action." When the piston of the triple valve moved through the entire length which it could travel, the stem of the piston came in contact with the stem of the emergency valve, opened it, which uncovered a port, and thereby the train pipe pressure was vented into the brake cylinder. The claims of the patent call the first or ordinary range of motion of the piston "a preliminary traverse," which admits air from the auxiliary reservoir to the brake cylinder, and the second range of motion "a further traverse," which enables the piston to admit air directly from the main pipe to the brake cylinder.

This invention, palpably and confessedly, lacked success in the Burlington trials. The reason of its failure and its remedy in No. 376,837 are described by Mr. Massey, a competent expert for the defendants and the patentee of the infringing valve, whose testimony upon this subject is admitted to be correct. He said, upon direct examination,in reply to the question : "What is the practical objection, if any, to the quick-action triple valve of 360,070, and how is that remedied by the apparatus of 376,837 ? Before answering, state what is meant by the 'Westinghouse Quick-Action Automatic Brake.'

"Ans. The term 'Westinghouse' Quick-Action Automatic Brake,' as used by Mr. Stone, undoubtedly refers to the quick-action triple valve described in Patent

376,837, and illustrated on sheet 2 of that patent. It is also the quick-action triple valve which is illustrated in the Westinghouse catalogue of 1890.

"In the quick-action triple valve described in 360,070, in addition to the triple valve, the stem of the piston came in contact with an emergency valve, and the extreme motion of the triple-valve piston caused the emergency valve to open a small passage between the train pipe and the brake cylinder, thus causing a local exhaust of the air from the train pipe, and, therefore, reducing the pressure in the train pipe quicker than would be done by the vent through the engineer's valve. The port which was opened by the emergency valve was necessarily restricted in size, as, in order to be effective, the piston of the triple valve must be able to open it within a moderate reduction of train-pipe pressure, and, therefore, with but little force in addition to that consumed by the piston in moving the ordinary triple-valve mechanism. If the emergency valve had been arranged to open a very large port, the time required to exhaust the train pipe through the engineer's valve, sufficiently to allow the piston to open the emergency valve, would be materially increased.

"This defect in the emergency valve of 360,070 would not be serious in trains of moderate length, as under, say, twenty-five cars; but in the 50-car train used at Burlington, in May, 1887, the effect was disastrous. This defect is remedied in 376,837, by using a supplemental piston to open the emergency valve and actuating that piston by fluid pressure from the reservoir through a passage controlled by a valve which is actuated by the triple-valve piston. In this case the triple valve system has only to open a comparatively small port, in addition to its regular function, and fluid pressure in the auxiliary reservoir then causes the supplemental piston to open the emergency valve."

The length of time required, in the use of the single valve of Patent No. 360,070, to open a sufficiently

large port, above referred to, appears to have been in the mind of Westinghouse in providing a separate piston of the patent in suit to open the emergency valve; for, in the description of this improved invention, it will be remembered, he states that "its object is to facilitate the application of brakes with great rapidity and full or approximately full force, as, from time to time, required, by the provision of means whereby the admssion of air from the brake pipe to the brake cylinders may be effected as directly as practicable, and through passages of as large capacity as may be desired."

No. 376,837 abandoned reliance upon the piston of the triple-valve as the means of opening the emergency valve, and used a supplementary piston, contained in a supplementary chamber and actuated by pressure from the auxiliary reservoir. The port, through which, when uncovered, this pressure passes, is, in the mechanism shown in the specification, uncovered by the excess stroke of the triple-valve piston. The description of the mechanism, which is contained in the next paragraph, is in the language of the opinion in the Circuit Court, and, inasmuch as the intricate mechanisms of the various devices which are the subject of discussion in the three cases, now grouped together, were accurately described by Judge Townsend, his language will be used, instead of attempting to formulate independent descriptions of the same series of devices: "This emergency action is secured in the patent in suit by means of a separate supplemental piston and valve in a supplemental valve chamber below the main slide valve of the triple-valve device. This chamber connects the train pipe with the brake cylinder, communication between them being regulated by the supplemental valve, opening outwardly or downwards, and a check valve opening inwardly or upwards. These valves are held upon the seats, under ordinary conditions, by a spring bearing upon their stems. In the bushing which forms the valve face of the main slide valve are four ports governed by said slide

valve. One of these ports leads to the brake cylinder, two lead to the supplemental-valve chamber on the upper or inner side of the suplemental piston, and one leads to an exhaust port.

" When an emergency stop is to be made, the engineer throws his engineer's valve wide open, thereby causing a sudden and material reduction of pressure. The excess of auxiliary reservoir pressure then forces the main piston stem against said other stem, overcoming the tension of its spring, drives the main piston to the extreme limit of its stroke, and thereby uncovers the ports leading from the auxiliary reservoir to the supplemental valve chamber. This pressure drives the supplemental piston outwardly, or downwards, against the stem of the supplemental valve, and forces it from its seat.

" Thereupon the preponderance of train-pipe pressure in the brake pipe opens the check valve, and the air from the train pipe rushes directly from the brake pipe to the brake cylinder.

" The result of this operation is two-fold. It hastens the application of the brakes on the car on which it is operated, and, by venting the train pipe, it hastens a similar reduction of pressure and consequent similar operation in the next succeeding triple-valve device on the next car.

" The release of the brakes is accomplished by the admission of air from the main reservoir."

The three claims which were found to have been infringed are as follows :

" I. In a brake mechanism, the combination of a chamber or casing having direct connections to a brake cylinder and to a brake pipe, respectively, a valve controlling communication between said connections, and a piston or diaphragm which is independent of, and unconnected with, a triple-valve piston, and is actuated by pressure from an auxiliary reservoir in direction to impart opening movement to said valve, substantially as set forth."

"II. The second claim includes 'a check or non-return valve controlling communication between said valve and the brake-pipe passage of the chamber, substantially as set forth.'

"III. In a brake mechanism, the combination, with a triple-valve, of a supplemental chamber or casing having passages leading to a brake cylinder and to a brake pipe, respectively, a supplemental valve, controlling communication between said passages, a supplemental piston operating independently of the triple-valve-piston, and adapted to impart opening movement to said supplemental valve, and a passage establishing communication between said supplemental piston and an auxiliary reservoir, substantially as set forth."

The vital parts of this mechanism are the supplemental chamber, having direct connections to the brake cylinder and the brake pipe, the valve 41, which controls communication between these connections, the emergency piston 63, independent and unconnected with the triple-valve piston, and actuated by pressure from the auxiliary reservoir in a direction to impart opening movement to the valve. To these essential parts, the defendant would add another, the particular means by which, in the specification, the emergency piston is actuated, viz.: the excess stroke of the triple-valve piston which uncovers the port 61, through which the auxiliary-reservoir pressure passes. Upon the scope of the invention, the question of infringement depends. The defendant insists that the only invention "resides in the use of an emergency piston, which is open to the exhaust port on one side and to the brake cylinder on the other side, and which is not subject to operative pressure from the reservoir, except by the extreme stroke of the triple-valve piston." The assignments of error are confined to this question, and the consequent construction of the first three claims, and to the question of infringement.

The defendants' theory mistakes the character and scope of the invention, which was another and successful way to accomplish the work designed to be accomplished by No. 360,070, and to be effected, upon the same general plan of instantaneous brake-pipe venting, by the new means contained in the supplemental chamber which have been named.

In No. 360,070 the stem of the triple-valve piston directly engaged with the stem of the emergency valve, and consequently its action directly depended upon the movement of the piston. The invention in 376,837 radically departed from this method of actuating the emergency devices, by making a new piston, independent of and unconnected with the triple-valve piston. It was to be actuated by auxiliary reservoir pressure, but the particular means by which this pressure was to be permitted to exert itself, whether continuously or only when a port should be opened, do not constitute an essential part of the invention. Means must necessarily be shown in the specification, but the identical means or the special devices were not, in the language of Morley Machine Co. vs. Lancaster, 129 U. S., 263, "necessary constituents" of the invention, either in the specification or in the claim. The skill and mechanical ingenuity of constructors of locomotives can, as will be seen hereafter in the examination of other patents and of the infringing devices, arrange different details of mechanical construction, by means of pistons, valves, ports and springs, which, adopting the supplemental chamber system first conceived and embodied by the patentee, and a kindred, but not precisely the same, mechanical method for the movement of the piston, will accomplish the same result. The patentee was a pioneer in that he designed, in No. 376,837, a new way to accomplish a desired result, but upon the same general idea which he had unsuccessfully tried to work out in the earlier patent. His later patent was the bridge, and not a mere step, which carried railroad-car builders

from failure to success. It is not important now to determine the grade of its pioneership, and whether it may be classed in the list of those inventions which are of the highest rank, but it was an invention created to achieve great necessities and overcome great hindrances, and was one of wide breadth. A court would not be justified in adopting "a narrow or astute construction" which should minimize the character of the invention, leave its real scope open to trespassers, and thus "be fatal to the grant." The claims of the patent do not contract the grant to narrower limits than those which the invention as made by the patentee actually covered, and the claims, therefore, are not limited to the precise mechanical means described in the specification, by which the supplementary piston is actuated. They compel it to be disconnected with and to be independent of a triple-valve piston, and to be actuated by pressure from an auxiliary reservoir by some means equivalent to the means which are described in the specification. The rule, which permits and indeed compels courts to give a wide range to the equivalents which a broad or pioneer patent can include, is thus expressed in Miller vs. Eagle Mfg. Co., 151 U. S., 186 : "If the invention is broad or primary in its character, the range of equivalents will be correspondingly broad, under the liberal construction which the Courts give to such inventions."

The defendant uses two forms of devices, known respectively in the case as "Defendant's Quick-Action Triple Valve" and "Defendant's Modified Quick-Action Triple Valve." Each has the supplementary chamber with its contents and in each the various elements conform to the general phraseology of the claims, but in neither does the movement of an emergency piston have any relation to the extreme movement of the triple valve piston, and herein is contained what is claimed to be the essential difference between the patented device and the defendant's valve. In the defendant's "Modified Valve" the pressure upon op-

posite sides of the emergency piston, numbered 13, which corresponds in function with emergency piston 63 of the patent, is always counterbalanced when quick action is not desired, whereas emergency piston 63 of the Westinghouse valve is not subjected to auxiliary pressure until its action is required, when port 61 is uncovered.

In the Defendant's Modified Valve, train pipe pressure is reduced when quick action is wanted, the auxiliary reservoir pressure becomes controlling, forces down emergency valve 20, which corresponds in function with the Westinghouse emergency valve 41, and which, when unseated, opens direct communication between the train pipe and the brake cylinder. This difference between the means which are used to actuate the pistons is not of a patentable importance. The operative features of the invention which are described in the three claims are the same, whether auxiliary pressure is permitted to exert itself continuously or intermittently when a port is opened.

The defendant's earlier device uses two pistons, the first, No. 13, is forced down by auxiliary reservoir pressure, but does not act directly upon the emergency valve. When forced down "it opens a port, whereby train pressure is admitted to the upper side of the other piston (No. 17), which, being thereby forced down, imparts opening movement to an emergency valve leading to the brake cylinder."

It is true that piston 13, which is the one actuated by auxiliary reservoir pressure, does not directly and of itself impart opening movement to the emergency valve, but uncovers a port which admits train-pipe pressure to the brake cylinder, and it is true that piston No. 17 is actuated by the train-pipe pressure thus admitted. These two pistons do the work of the one piston of the defendant's modified valve. Auxiliary reservoir pressure moves the piston which, through the intervention of piston 17, imparts opening movement to the emer-

gency valve. Mr. Massey states the difference between the two valves of the defendant to be that, in the "Quick Action Triple-Valve," the initally operating piston 13 actuates the emergency valve indirectly; that is to say, through the intermediation of the piston 17; while, in the other valve, the initially operating piston 13 actuates the emergency valve directly, as in Patent 376,837." This is not a material difference of a patentable character when considered with reference to this patent, and the result is that each of the defendant's valves is an infringement. The "quick-action valve" infringes the first three claims, while the second form, not having the additional check valve of the second claim, infringes the first and third claims.

No. 448,827 will next be considered. The form of automatic air brake apparatus shown in this patent was originally included in the application for No. 376,837, which also included the form which has been already described, in which port 61 was uncovered by the excess stroke of the triple-valve piston. But the applicant was precluded, by a rule of the Patent Office, from adding to his generic claims a specific claim for the form which is now described in No. 448,827, and therefore a subordinate patent was applied for.

The details of the device are described by Judge Townsend, as follows:

"The alleged invention consists of a valve, controlling communication between a supply passage from the train pipe and a delivery passage to the open air or a brake cylinder. This valve is held in position by a spring, so as to close ports leading to the delivery passage, and not to be moved from its seat by ordinary reductions of pressure for service stops. There is also a diaphragm and valve stem, interposed between the supply passage and a passage to a special reservoir or an auxiliary reservoir. Said controlling valve is connected to said valve stem. Train-pipe pressure passes through a small passage in said diaphragm into said

reservoir, thus equalizing pressure on the opposite sides of said diaphragm.

"Upon a sudden reduction of pressure, sufficient for an emergency stop, the excess pressure on one side of said diaphragm moves it and its valve stem and the said controlling valve downwardly, so as to open said ports and allow the compressed air to pass through the delivery passage to the open air or brake cylinder."

The two claims of the patent which are said to have been infringed by the defendant's two valves, which have been before described, are as follows:

"1. In a fluid-pressure brake apparatus, normally operated by a triple-valve device, the combination with such an apparatus of a valvular appliance having a casing, provided with supply and discharge passages or connections, and a valve, controlling an exhaust port from the supply passage to the discharge passage, for quickly releasing pressure in the supply passage, said valve being actuated to open the exhaust port by a greater than normal reduction of pressure in the supply passage, independently of the action of the triple-valve device, substantially as set forth.

"2. The combination with a triple-valve mechanism of a discharge valve controlling an exhaust port from a supply passage to a discharge passage for quickly releasing the pressure in the supply passage, said valve being actuated to open the exhaust port by fluid pressure in an auxiliary reservoir on reduction of pressure in the supply passage below the normal degree, in whatever position the slide valve of the triple-valve mechanism may be brought by such reduction, substantially as set forth."

Infringement of these claims is admitted, and the only question is in regard to their validity.

The distinctive feature of the alleged invention is that the emergency valve is actuated to open the exhaust port "independently of the action of the triple-valve device."

The theory of the complainants is that, whereas the leading characteristic of novelty in Patent No. 376,837 is the "utilization of auxiliary reservoir pressure operating a supplemental piston in proper direction to impart opening movement to the emergency valve," the invention of No. 448,827 was the means of imparting movement to the valve by "auxiliary pressure, so applied that the action or non-action of the triple-valve piston shall be eliminated as an element of control," and that its distinctive feature was "the removal from the apparatus of all *obstructive* mechanical connection between the triple piston and emergency valve, whereby the latter may be impeded in its movements by the former."

This theory omits an important characteristic of the novelty of No. 376,837, which is the independency and disconnection of the supplemental piston from the triple-valve piston. In the form left in the application for the patent, after the divisional application was made, there was no mechanical connection between the two pistons, but the stroke of the triple-valve piston exercised a control over the movement of the supplemental piston, by uncovering the port which admitted auxiliary reservoir pressure. The form in 448,827 permits, as do the defendants valves, auxiliary reservoir pressure to be present at all times and to act upon the piston, but counterbalanced during ordinary service stops. It was included in the generic claims of No. 376,837, and in view of those claims no invention could consist in the mere fact of the elimination of the action of the triple-valve piston as an element of control. When the patentee obtained the broad claims of No. 376,837, he exhausted his power to obtain additional patents for mere modifications of means by which the piston should be made independent of the triple-valve piston, unless the modification contained a patentable improvement upon the form disclosed in that patent. For any new and useful improvement which contained also

the element of invention, or for a separate invention, a subordinate patent could be obtained.

Were the changes made in 448,827, after the idea of 376,837 had been embodied in its original form, the work of invention? So far as the first two claims are concerned, the changes consisted in a port from the auxiliary reservoir to one side of the emergency piston, which port was always open, and the counter-balance to reservoir pressure by a spring on the opposite side of the piston so that ordinary variations of pressure would not destroy the equilibrium necessary to be maintained until excessive reduction of pressure should take place. In view of the various forms and modifications and improvements of automatic brakes and brake-mechanism, which had been made known before the date of this invention and which are a part of the record in these three cases, there was no patentable invention in this modified form, apart from the invention shown in No. 376,837. It was simply what the patentee first deemed it to be, a form of the invention of that patent and covered by it. The first two claims of No. 448,827 contain no patentable improvement upon the form specifically described in the claims of its predecessor and are void.

We omit any description of the other grounds upon which the invalidity of these claims is placed by the defendant.

No. 393,784. This patent is subordinate to 376,837. The device which it describes has the supplemental chamber with the emergency piston and valve, and the important elements of the Westinghouse Patent, except that the emergency valve is moved by train-pipe pressure, instead of by auxiliary reservoir pressure.

"This result was accomplished by providing a separate emergency piston and valve, ordinarily exposed to train-pipe pressure above said piston, which pressure served to hold the valve on its seat, and was not affected by ordinary reductions of pressure for service stops.

But the considerable reduction of pressure necessary for an emergency stop caused air from the train-pipe to be vented into the space below said piston, equalizing the pressure on both sides and, acting on the under side of said valve, causing it to be unseated and to thus allow the train-pipe pressure to be vented directly into the brake-pipe cylinder."

The claims said to be infringed are as follows:

"1. In a brake mechanism, the combination of a valve controlling the direct passage of pressure from a train-pipe to a brake cylinder, a piston connected to said valve and actuated wholly by train-pipe pressure, and a valve controlling the train-pipe pressure on the piston for opening and closing the communication between a train-pipe and a brake cylinder through the direct action of train-pipe pressure, substantially as specified.

"2. In a brake mechanism, the combination of a train-pipe, a brake cylinder, an interposed chamber communicating with the train-pipe and brake cylinder, a piston in said chamber, a piston stem, a valve on the piston stem controlling the passage from the interposed chamber to the brake cylinder, and a controlling valve and passages for the admission of pressure from the train-pipe to move the piston and open the valve, substantially as and for the purposes specified."

The emergency piston 13 in the defendant's "Modified Valve" is actuated wholly by reservoir pressure, and this valve is, therefore, not claimed to be an infringement. The emergency piston 13 in defendant's "Quick-Action Valve" is forced down by reservoir pressure, but when it is pressed down it causes train-pipe pressure to be admitted, which acts upon and presses down piston 17, whose spindle presses upon and unseats the emergency valve. Inasmuch as the valve is disconnected from piston 17, it is returned to its seat when train-pipe pressure is removed from the upper side of the piston, mainly by the elastic force of a spring.

This patent is a subordinate one and must receive a narrow construction. It is not permissible to give to the terms of a patent of that class so wide a sweep as to include the various devices which may actuate an emergency valve in a supplemental chamber by train pipe pressure, and the range of its monopoly is a limited one. The language of each claim indicates that a connected valve and piston were to be employed, and Park's method of opening and closing the valve required that they should be mechanically connected. A mechanical connection would not be indispensable, unless there was a necessity for it, or unless a mechanical separation created a difference in the means by which the result was accomplished, which, in view of the narrowness of the invention, was a radical difference. The Park piston holds the valve to its seat, in the normal condition of pressure. It is lifted up when the valve is lifted by train-pipe pressure, and, when extraordinary pressure is removed, it restores the valve to its seat. It does not unseat the valve. The defendants' piston does not hold the valve to its seat and does not restore it to its place. When train-pipe pressure comes upon the upper side of the piston and forces it down, it unseats the valve, and, after pressure has been removed, the spring, as it resumes its shape, returns the valve to its seat. The difference in the way in which the two pistons accomplish the general result would not be a substantial one in a primary patent. It is substantial with respect to an invention which merely substitutes train-pipe pressure for the auxiliary reservoir pressure which Westinghouse used. The Circuit Court properly held that neither claim was infringed.

No. 172,064. The invention of this patent was an improvement upon the improvement patented to Mr. Westinghouse by Patent No. 168,359, and was a part of the brake apparatus used before the invention of the quick-action brake. It related to the direct admission

of air from the brake pipe to the brake cylinder. The defense that the defendant uses the original and not the later improvement was satisfactorily sustained. The peculiarity of the patented invention and of the device used by the defendant is shown in Judge TOWNSEND's description, as follows:

"Patent No. 168,359 provides for a piston and slide valve, so arranged that air pressure transmitted through the train pipe shall pass on the under side of the piston, and hold it in an upward position, and thence pass through a side port in the piston-valve case, and certain other ports and passages, into the auxiliary reservoir.

"The effect of this pressure is to hold the slide valve in position above two connected ports, one leading to the brake cylinder, the other to the open air, so that any pressure in the brake cylinder will escape to the open air, and the brakes will be off. When the pressure is reduced, in order to apply the brakes, the back pressure from the auxiliary reservoir depresses said piston so that it passes down and closes the supply ports and shifts the slide valve, so as to open the port leading to the brake cylinder and exposes it to auxiliary reservoir pressure, and so as to close the port leading to the open air.

"In Patent No. 172,064, the inventor dispensed with said side port in the valve case and substituted therefor a port through the pistion itself. The piston was so arranged, in connection with this port, that said port could be opened or closed without moving the slide valve. This was accomplished by having the stem of the piston fitted to the port in the piston, so that it would close the port when moved into it and open it when removed, and by further providing that the slide valve should be made shorter than the distance between the collars on its stem, thus insuring the necessary slack motion for closing the supply port before the slide valve begins to move.

"Claim 3 is as follows:

"3. The slide valve H, made shorter than the distance between its end bearings, in combination with the port s and stem c^1, or relatively arranged with reference to the operation of the valve H while the port s is closed, substantially as set forth.

"Defendants' device, as illustrated by 'Defendants' plain triple valve,' contains the slide valve, made shorter than the distance between its end bearings, on the piston stem. It is also provided with two ports, one of which leads from the train pipe, through the piston chamber and by other passages to the auxiliary reservoir. The other port leads from the auxiliary reservoir to the brake cylinder. This port is closed by having the end of the piston stem slide on to it and cover it, like a valve upon its seat.

"There is no port through defendants' piston, and, consequently, no piston stem fitted to enter such port."

The claim is for the valve made shorter than the distance between its bearings with the specified improvements upon 168,359, viz.: the air port through the piston, which is opened and closed by the stem. The effect of this arrangement is stated in the specification, as follows:

"The port s will be closed before the valve H begins to move for applying the brakes, and will be kept closed until the valve H shall have been brought back to the proper position for a full release of the brakes. Consequently, the valve H can be operated as may be desired in applying and releasing the brakes and in graduating the brake pressure, without leakage or loss at the air-supply port s, and with such port always closed."

It is undoubtedly true that the two devices accomplish the same result and close the supply port before the valve begins to move, but infringement can only be found by giving a construction to the third claim, which disregards the fact that No. 172,064 substitutes the air port s with its plug c for the side port of 168,359.

The conclusion which the Circuit Court reached was the correct one.

It was stated as follows:

"Inasmuch as complainants claim a combination which contains a port through the centre of a piston, described as substituted for a side port, with which said improvement dispenses, and as defendants' device depends upon the use of a side port, and has no port through the piston, but is made up by a combination of different elements, which are admitted in Patent No. 172,064 to be a part of the prior art, the combination claimed in claim 3 of said patent is not infringed.

"A correct construction of the claim must include the port through the centre of the piston, substituted for the side port of Patent No. 168,359."

The invention of No. 222,803 was an engineer's valve, which, speaking in very general terms, should, by the movements of a single stem or lever, admit and automatically stop admitting fluid pressure to the brake pipes, by means of a charging valve, automatically retain such pressure and permit its escape by an exhaust valve, with means for automatically closing either valve when the desired pressure had been charged into or withdrawn from the train pipe to which the device was connected.

The patentee summarized, in his specification, his invention, as follows:

"It will now be seen that I provide for operating both the supply and the exhaust valves by a single stem, that only one can be opened at once, that either may be opened separately (much or little), and that both may be closed simultaneously and automatically and kept closed whether the brakes are on or off."

This automatic closing of the charging and exhaust valves was a very important part of the invention.

The patented valve, so far as the second, third and fourth claims are concerned, "consists of piston case, containing a piston, governing a charging valve held up

to its seat, partly by fluid pressure and partly by a spring, and an escape valve held down to its seat, partly by gravity and partly by a preponderance of fluid pressure on its upper end.

This governing piston is exposed on its under side to fluid pressure, and on the upper side to pressure from a spring. A screw-stem worked by a crank-arm, is so arranged in connection with said spring that, by the revolution of the crank-arm, the downward pressure of said spring upon said piston is increased or lessened.

The effect of such change of pressure is to cause the piston to be moved upwards or downwards according as it is acted upon by an excess of fluid or of spring pressure, and to open or close the charging and escape valves.

Beneath the lower end of the escape valve, provision is made for a certain amount of slack motion, so that the governing piston may be moved up or down for a short distance without unseating the escape valve. The effect of this arrangement is to prevent the possibility of both valves being open at the same time.

The operation of said apparatus is as follows :

In order to apply the brakes or to open the charging valve, the crank arm is screwed down, and this increase of pressure, transmitted through the stem of the piston-head to the charging valve, unseats it and permits fluid pressure to pass from the boiler or storage reservoir to the train pipe and brake cylinders.

The fluid pressure also passes upward to the space below the piston head and exerts the same pressure upon it as in the train pipe or brake cylinders.

The engineer knows, from his engineer's gauge, just how far to screw down his crank, so that, when the necessary amount of pressure has passed through to the train pipe or brake cylinder, the same pressure will automatically lift the piston and close the charging valve.

The crank arm is screwed up in order to open the escape valve, and, after the proper amount has been

discharged, the escape valve automatically closes in the same way as already shown in the case of the charging valve.

The three claims which the Circuit Court found were infringed are as follows:

"2. As a means for automatically cutting off the fluid-pressure supply when the desired pressure has been charged into the brake cylinders, a piston head P, movable by the operative brake pressure or any excess thereof, in combination with the charging valve and a connection from one to the other, substantially as set forth, whereby such movement of the piston head will result in the automatic closing of the charging valve, substantially as set forth."

"3. The combination of piston head, charging valve, interposed stem and escape valve, substantially as set forth, with reference to the opening and closing of the charging valve, without necessarily opening the escape valve, substantially as set forth."

"4. The combination of piston head, charging valve, interposed stem, escape valve and a single operating stem, adapted by independent connections with both valves to shift both by independent successive motions, substantially as set forth."

The defendants' valve has a single lever which is moved from side to side by a single handle having a reciprocating motion. The valve has also a piston exposed to fluid pressure on both sides, which controls a charging and an escape valve, which perform the same functions as in the patented valve.

"The main lever, which is fastened to said handle, carries an eccentric pin, which passes through said lever, and which moves in the arc of a circle. The right end of the lever is held stationary by a jaw and fulcrun pin; the left end, when said handle is moved to the right, is lifted by the rock-shaft motion imparted by said pin, and strikes against another pin, attached to the escape valve, and raises and opens said escape valve. This lever has

also an upper jaw, which moves in a pin attached to a bell-crank lever, the arm of which is directly beneath the charging valve. In order to open this valve the handle is moved to the left, which causes the main lever and pin to move to the left, and to raise the arm of the bell-crank lever and open the charging valve. Provision is made for slack motion by a space between the top of the escape valve and said pin attached thereto, whereby the left end of the main lever is permitted to have a certain amount of play before it strikes said pin."

In addition to fluid pressure, the piston is "acted upon from below by a bell-crank lever, or bent lever with vertical arms, connected by links to the piston, and to a second lever, which second lever is connected with a light spring."

An attempt was made in the testimony to claim that the patented valve lacked novelty, or that its descent could be traced from Patents No. 129,015, dated July 16, 1872, issued to Fay & Cairns, and No. 141,685, dated August 12, 1873, issued to George Westinghouse, Jr. The Fay & Cairns Patent was for an apparatus for regulating the flow of water in houses and shutting it off when there is an excess of pressure, so as to prevent the bursting of pipes. The Westinghouse Patent was for a triple valve and it was admitted in the course of the testimony that the patent described nothing designed for or capable of performing the functions of the engineer's valve. The Fay & Cairns invention was a pressure regulator, contained no exhaust valve, and could not be an engineer's valve. The idea that either of these patents anticipated or restricted the patentable character of the whole invention is not now entertained. The defendant is, however, of opinion that No. 141,685 is an anticipation of the second claim. The importance of this suggestion will be considered hereafter.

The invention, as a whole, is thus conceded to be without a predecessor, and the importance of an inven-

tion by which both valves could be automatically closed upon the desired amount of pressure being charged into or exhausted from the train pipe is manifest.

The object of the defendants' valve is by the movement of a single handle to accomplish the same results which the patented valve attains, and it is conceded that the valve has a piston head, movable by operative brake pressure or any excess thereof, a charging valve, an escape valve and interposed connections so arranged that the charging valve may be opened and closed without necessarily opening the escape valve, a connection between the piston head and charging valve, consisting of a bell-crank lever, a pin and lever and a projection on the piston head, and that by reason of this connection a movement of the piston head under the operative pressure or any excess thereof, will result in the automatic closing of the charging valve.

But it is contended that the second claim of the patent is void by reason of the Fay & Cairns Patent, that the defendants' valve has not the interposed stem of the third and fourth claims, because the motion of the complainants' piston always acts through the stem to open the valve, that the defendants' piston does not open the charging valve as required in the third claim and does not open either valve, except only that the pin carried by its piston is the fulcrum of the lever when the escape valve is opened, whereas, neither of the valves in 222,803 can be opened except by moving its piston, and therefore that the true construction of the third and fourth claims is as follows:

In regard to the third claim: "The combination of a piston for opening and closing two valves by reverse motions of the piston; those valves; and a part interposed, whereby the motion of the piston in one direction, from its position with both valves closed, opens one of the valves, and its return motion allows that valve to close, while its motion in the opposite direction opens the other valve and its return motion allows that valve to close." In regard to the fourth claim: "The above

combination, with the addition of a single handle by means of which the engineer can vary the pressure on one side of the piston."

The second claim of the Patent contained the case provided with a piston chamber and valve chamber in addition to the three elements which are specifically named.

The Fay & Cairns patent was a water pressure regulator. The specification says that it consisted of a hollow cylinder attached to a valve and communicating at one end with the water pipe into which the water flows through the valve. In the cylinder is a piston whose rod is connected to the valve, a coiled spring is behind the piston under such tension as to hold the valve open until the pressure becomes too great for the pipe beyond the valve, when the water pressure on the piston closes the valve and keeps it closed until the pressure on the piston and in the pipes falls below the power of the spring, when it will open the valve cylinder. There is no exhaust valve, but claim 2 does not include an ex haust valve, and the valve is connected with the piston, whereas, in No. 222,803 the charging valve is closed by a separate spring, but this is thought by the defendants to be immaterial in a structure not having an exhaust valve, "the purpose of separation being to permit a further upward movement of the piston so as to open the exhaust valve after the charging valve has been seated." The needs of a water pressure regulator to be attached to a water pipe which conveys water into a house, and an engineer's valve in which there must be a charging and an escape valve are very different.

In an engineer's valve, opened by a single stem, the charging valve must be separated from the piston or the device would be useless, and it is no answer to the validity of the claim to say that some other fluid-regulating device was operated by a different arrangement of valve and piston which, though it might come within the general terms of that claim, would be useless in the device which was the subject of the patent.

The great dissimilarity in form and appearance between the patented valve and the defendants' valve tends to confuse the mind when the question of the infringement of the third and fourth claims is first looked at. The defendants' valves and piston are not arranged in the same axial line, motion is not communicated to the piston in an endwise direction, but through a series of bell-crank levers, which at first seem to be operating upon a different system from that of the patent. A closer examination shows that the series of operations in the patented valve is substantially reproduced in the defendants' valve by like instrumentalities. It is not denied that the defendants' valve has a series of levers and pins which may be called an interposed stem, and which communicate motion somehow, but it is said that its piston and its stem do not correspond with these elements in the 3d and 4th claims, mainly because in the Westinghouse device the motion of the piston acts through the stem to push the valve open, and the defendants' piston does nothing to open either valve.

It is true that, in the Westinghouse valve, there is a direct connection between the piston and the charging valve, and that the movement of the piston opens the valve, and that, in the defendants' valve, the charging valve is opened by the manual movement of the handle and lever 49, and the piston, at the time, remains stationary.

By the subsequent movement of the piston, when sufficient train-pipe pressure has been admitted, the charging valve is closed automatically.

It is also said that the defendants' piston does not open the escape valve, except that the pin carried by the piston is the fulcrum of the lever when the escape valve is opened. This may also be considered as true, but it should also be said that there is an upward movement of the piston before the valve is opened.

As explained by Mr. Barnes for the complainant, the movement of the handle to the right raises the ful-

crum of the lever, which imposes upward pressure upon the piston; it moves upward until the elastic resistance below the piston is reduced so much that the train-pipe pressure on top of the piston can lift the escape valve by means of the lever known as 43.

If the third and fourth claims require that one or both valves must be both opened and closed by the motion of the piston, and that the interposed stem must move with the piston to open one or both valves, then there is no infringement. The third claim, for example, is for the combinatio of piston-head, charging valve, interposed ste and escape valve with reference to the opening an closing of the charging valve. As the invention did not consist in the particular way in which the elements of this combination co-operated, in reference to the mere opening of the valve, and as the language of the claim is not limited to anything more narrow than the actual invention, the construction which the defendant seeks, is not necessary; the only question is whether the differences which have been stated, and which are, in substance, the difference between the direct action, in the patented device, of the piston, through the interposed stem, in opening the valves and the action of the bell-crank lever, pin and lever, which are the interposed stem of the defendants' device, constitute such a departure from the means which the patentee used and described, as to constitute new and different means which escape a just charge of infringement.

The question of infringement is controlled by the principles restated in Morley Machine Co. vs. Lancaster, 129 U. S., 263, and confirmed in subsequent and recent cases (Miller vs. Eagle Mfg. Co., *supra*), and which makes these actual differences, which would be important in a subordinate patent, unessential when a patent for a pioneer invention is under examination. If such differences should be regarded by Courts as essential, when the claims do not make the specific de-

vices essential, patents for pioneer inventions would ordinarily have but little value.

All the decrees of the Circuit Court in case No. 4976, and in case No. 4977, which have been appealed from, are affirmed with costs of this Court. The interlocutory decree of the Circuit Court in case No. 5315 is reversed with costs of this Court, and the cause is remanded to that Court with instructions to dismiss the bill with costs of that Court.

George H. Christy, Frederic H. Betts, J. Snowden Bell, for the complainants.

J. E. Maynadier, Fredk. P. Fish, Esek Cowen, Edward C. James, for the defendants.

UNITED STATES CIRCUIT COURT.

SOUTHERN DISTRICT OF NEW YORK.

THE WESTINGHOUSE AIR BRAKE CO.

vs.

THE NEW YORK AIR BRAKE CO.

LACOMBE, Circuit Judge.

This is an application for a preliminary injunction under three patents, viz: No. 360,070, March 29, 1887, to George Westinghouse, Jr. No. 376,837, January 24, 1888 to the same, and No. 393,784, December 4, 1888 to Harvey S. Park.

It is unnecessary to enter into any elaborate statement of the history of the art, and of the impress left upon it by these inventions. That entire subject has been discussed with great care and set forth at great length in the former opinions of this Court and of the Court of Appeals delivered in the earlier actions between these same parties: 59 Fed. Rep. 581, 63 Fed. Rep. 962. In those opinions it is held that the two patents 360,070 and 376,837 disclosed, the one the emergency valve, the other the supplemental piston or special motor, which, so far as the art has now progressed, appear to be both essential to the structure of a successful quick action air-brake. Both of these inventions achieved great necessities and overcame great hindrances; each is an indispensable part of the "bridge which carried railroad car builders from failure to success"; both were products of the inventive genius of the same man; nothing anticipating either is shown: and the defense of the defendant, in the former action and in this, may truthfully be described in terms of another art:—

by bringing the two patents into juxtaposition, they seek to short-circuit the claims and thus dissipate the invention. This attempt failed in the former suit, wherein No. 376,837, the patent sued upon, was held to be one of wide breadth—one as to which "a court would not be justified in adopting a narrow or astute construction which should minimize the character of the invention, leave its real scope open to trespassers and thus be fatal to the grant". Wherefore, the Court of Appeals held it to be entitled to a liberal construction with a wide range of equivalents. Although No. 360,070 was not declared upon in the earlier suit, it was discussed at great length and its meritoriousness was clearly recognized. The statements of the problem to be solved, as it stood prior to January, 1888, and of the contribution of 360,070 to that solution, as they are set forth in the opinions above cited. leave no doubt that both the Circuit Court and the Court of Appeals regarded it as a patent of wide breadth, the only difficulty being to find sufficient standing room within the field it occupied to permit of according to 376,837, also, the necessary breadth of construction to cover the infringing devices then before the Court, and thus save to a meritorious inventor the fruits of his novel and most useful invention.

Defendant relies upon the rejection by the Patent Office of the original first claim of 360,070 and the substitution of the present first claim, as an abandonment of the fundamental broad invention therein disclosed. When, however, the reference on which the Patent Office rejected the original first claim (Boyden's Patent, No. 280,285) is consulted, it is apparent that the essential change in the claim is the phrase used to differentiate 360,070, an invention to be used "in the application of the brake", from Boyden's invention, whose object was to provide for replenishing, "while the brake is on", the air reservoir or brake cylinder, when the pressure is reduced by leakage &c. There is nothing in the file wrapper or contents to show that the Patent Office required or that the inventor agreed to abandon what was

the great feature of his invention—the emergency valve, or to give up whatever range of equivalents his patent might, as modified, fairly cover.

Both these patents, 360,070 and 376,837, are broad ones, and their claims should be construed to cover the meritorious invention they disclose, unless the language of such claims precludes such a construction. The only question really open on this motion is that of infringement.

Patent No. 360,070.

The first claim of this patent is as follows:

"I. In a brake mechanism, the combination of a main air pipe, an auxiliary reservoir, a brake cylinder, a triple valve, and an auxiliary valve device, actuated by the piston of the triple valve and independent of the main valve thereof for admitting air in the application of the brake directly from the main air pipe to the brake cylinder substantially as set forth."

Defendant's device has the main air pipe, an auxiliary reservoir, a brake cylinder, a triple valve and an auxiliary valve device, independent of the main valve, for admitting air, in the application of the brake, directly from the main air pipe to the brake cylinder. The means for actuating the auxiliary valve device is stated in the claim to be "the piston of the triple valve". And the way in which it acts, as shown in the patent, is by direct impingement upon the stem of the auxiliary valve device. In defendant's structure the piston of the triple valve acts upon the auxiliary valve device, not directly, but by opening a port, which reduces pressure on one side of another piston in a supplementary chamber, the movement of such supplementary piston opening the emergency valve. None the less is the auxiliary valve device "actuated" by the piston of the triple valve, though two pistons do the work of one, and the action of the triple-valve piston is indirect instead of direct. Such an addition to the mechanical details of the combination is within the doctrine of equivalents, when the original invention is a broad one, as this undoubtedly is, and the language of the

claim fairly covers it, which is the case here—the word "actuated" being applicable equally to indirect and to direct actuation. Nor will it avail defendants, as against the claim of a broad patent, that the addition to the mechanism is itself an advance in the art—an advance, it may be noted, which is not theirs, but one they have appropriated from a subsequent patent of the same inventor. The person who discovered the advantage of a supplemental motor for the emergency valve and devised its mechanism, was, as the Court of Appeals has held, entitled to a broad patent for that highly meritorious invention, which was essential to complete success in the art: but that circumstance did not entitle him to appropriate the meritorious and equally essential emergency valve of the earlier patent, so long at least as he actuated his supplemental motor in the the way in which such earlier patent claimed, viz: by the piston of the triple valve.

The second claim of No. 360,070 is as follows:

"2. In a brake mechanism, the combination of a main air pipe, an auxiliary reservoir, a brake cylinder, and a triple valve having a piston whose preliminary traverse admits air from the auxiliary reservoir to the brake-cylinder, and which by a further traverse admits air directly from the main air pipe to the brake cylinder, substantially as set forth."

The discussion of the first claim applies equally to this one. In the first claim, actuation by the piston of the triple valve was made an element. In this claim, the inventor more closely limits the mode of such actuation. It is to be by a "further traverse" of that piston. The means shown in the patent is by direct impingement upon the stem of the emergency piston; the defendants avail of the "further traverse" to set in motion supplementary devices which act upon the emergency valve. Both these clanns are infringed, as is also the fourth. The fifth, which has not been elaborated upon the argument, contains the additional element of a check valve, and the question of its infringement may be left for final hearing.

Patent No. 376,837.

The first claim of this patent is as follows:

"1. In a brake mechanism, the combination of a chamber or casing having direct connections to a brake cylinder and to a brake pipe respectively, a valve controlling communication between said connections, and a piston or diaphragm which is independent of and unconnected with a triple-valve piston, and is actuated by pressure from an auxiliary reservoir in direction to impart opening movement to said valve, substantially as set forth".

This is the "supplemental chamber system first conceived and embodied by the patentee", an invention which the Court of Appeals has held to be a broad one, and entitled to a wide range of equivalents. When we speak of anything as actuated by air pressure, the phrase necessarily implies movement in one direction or another, as the pressure is increased or diminished. Whether it is set from rest into motion by applying pressure or by withdrawing it, the phrase "actuated by pressure" fairly describes the operation.

The question whether defendant's present device infringes this claim, as did the two devices which were before the Court in the former suit, is a narrow one. The claim of the patent is so fully discussed in the decision of the Court of Appeals, that it will only be necessary to describe defendant's new device.

The supplemental piston Q, when at rest, is pressed upon from below by train-pipe pressure. It remains at rest, because the space between its face and the enclosing walls of the chamber in which it moves is filled with air of like pressure, which reaches such space from the train pipe through two narrow conduits *p* and *u* and a connection *t*. When the device is actuated, upon the excess stroke of the triple-valve piston, the connection *t* is moved, the conduit *p* is, for an instant, closed and then opened to the outer air. Thereupon, the space above the piston is voided of compressed air, and the train-pipe pressure from below, being no longer counterbalanced by pressure in the chamber above, moves

and unseats the valve. It is actuated, therefore, by the withdrawal of the air pressure from the chamber above, which, before it is thrown open to admit of such withdrawal, has been cut off from all connection with the train pipe. Pressure from the auxiliary reservoir at no time operates upon it, either to hold it at rest or to put it in motion. Defendant contends that the claim of the patent must be restricted so as to cover only supplemental devices which are actuated by pressure from the auxiliary reservoir and therefore that its present device does not infringe. The phrases "train-pipe pressure" and "auxiliary reservoir pressure" had, prior to the granting of this patent, acquired a well-known meaning in the art, and the use of one in a claim could hardly be construed to mean the other. But complainant contends that the phrase used in this claim, to describe the means for imparting motion to the supplemental piston, is not "actuated by auxiliary reservoir pressure" nor "actuated by pressures from *the* auxiliary reservoir", but "actuated by pressure from *an* auxiliary reservoir." If some one should reproduce every detail of the claim, with the single exception of adding a separate and additional chamber or reservoir, which was charged from the auxiliary reservoir and then cut off from it, and should use the force thus stored in that additional or supplementary chamber or reservoir for the sole purpose of imparting motion to the supplemental piston, his device would, within the ordinary use of words, contain the element of actuation "by pressure from *an* auxiliary reservoir", whether the additional chamber were contained, as a sub-reservoir, within the auxiliary reservoir proper, or was placed entirely outside of the latter. The charging of such additional reservoir, not from the auxiliary reservoir but in the same way as the auxiliary reservoir itself is charged, viz: by admitting train pipe pressure into it through a charging port and then cutting off connection with the train pipe, does not seem to involve any substantial difference. And, where the patent is a broad one, as this is, with a full range of equivalents, the

maker of such a device may fairly be held an infringer. Whether the device of the defendant contains such an additional auxiliary reservoir in the chamber P, above the piston face, is the question in dispute. For the brief moment when, after being charged, it is cut off from the train pipe it seems to be such and the compressed air which it contains to be within a broad definition of "auxiliary reservoir pressure", viz: air compressed at the locomotive and which, passing through the train pipe, has got beyond a charging port which thereafter cuts off its connection with the source of supply, and detains it as stored-up pressure to be used in an emergency.

In view of the broad construction given to 376,837 by the Court of Appeals, the defendant's device must be held to infringe this claim. Infringement of the third and fourth claims is not so clear, and those questions must be reserved for final hearing.

Patent No. 393,784.

This is the patent to Park, which the Court of Appeals held to be a subordinate one, entitled to but a narrow construction. Infringement is doubtful, and the question had best be determined upon fuller testimony at final hearing.

Complainant may take an order for preliminary injunction in conformity with this opinion.

December 27, 1894.

[Endorsed] Circuit Court of the United States for the Southern District of New York.—The Westinghouse Air Brake Co. vs. The New York Air Brake Co.—Opinion.—Lacombe, C. J.—U. S. Circuit Court, filed, Dec. 27, 1894, John A. Shields, Clerk.

(A copy.)

[seal.] John A. Shields,
Clerk.

U. S. Circuit Court of Appeals,

SECOND CIRCUIT.

THE WESTINGHOUSE AIR BRAKE CO.,
Appellee,

vs.

THE NEW YORK AIR BRAKE CO.
ET ALS.,
Appellants.

Per Curiam:

We agree with the Court below that the defendant's apparatus is an infringement of the first, second and fourth claims of Patent No. 360,070, and deem it unnecessary to add anything to the opinion of Judge Lacombe. The question whether the apparatus is an infringement of the first claim of Patent No. 376,837 is too doubtful to be resolved in favor of the complainant upon a motion for a preliminary injunction, and should be reserved for disposition upon the final hearing of the cause. So far as the order appealed from allows an injunction for the infringement of this claim it should be reversed; otherwise, it is affirmed.

Ordered accordingly.

[ENDORSED.] U. S. Cir. C. of Appeals, Second Cir. The Westinghouse Air Brake Co., Appellee, vs. The New York Air Brake Co. et als., Appellants. *Per Curiam.* United States Circuit Court of Appeals, Second Circuit. Filed May 28, 1895. James C. Reed, Clerk.

(A copy.)

[SEAL.] JAMES C. REED,
Clerk.

PREFATORY NOTE.

One or two preliminary matters may require a word of explanation:

FIRST. The composite character of the transcript may be a surprise to the Court.

The Boyden parties, defendants below, in order to get an early hearing in the Court of Appeals, procured an *ex parte* order from Judge GOFF, under which the reprinting of the record was dispensed with in the Court of Appeals, and eight composite records were made up by binding together and repaging the records used by the opposite parties on final hearing in the Circuit Court—only a few preliminary and supplementary pages being added.

See "Proceedings in the United States Circuit Court of Appeals, Fourth Circuit," at end of "Transcript," pages 1, 2 and 3.

It is in this way that the "Transcript" now before the Court has acquired its composite form or character.

It consists of:

1st. The title, index, etc., pages I.–VII., followed by an unpaged leaf.

2d. The Westinghouse (complainants') record, as printed for use in the Circuit Court, pages 1–720.

3d. Documentary exhibits used in the Circuit Court, pages 721–794.

4th. The Boyden (defendants') record as printed for use in the Circuit Court, pages 795–1185.

5th. Documentary exhibits, pages 1186–1338.

6th. Westinghouse (complainants') proofs in reply in Circuit Court, pages 1339–1359.

7th. Opinion of Judge MORRIS in Circuit Court, decree, appeal, etc., pages 1361–1388.

8th. Next follows "Transcript of Cross-Appeal" in terra-cotta covers, pages 1–9.

9th. Lastly, and immediately following, are the "Proceedings in the United States Circuit Court of Appeals, Fourth Circuit" (pp. 1–30).

And herein will be found the opinion of the Court of Appeals, as rendered by Judge HUGHES, commencing with (p. 5) "Statement," and followed by "Opinion" (p. 15).

SECOND. The attention of the Court ought, perhaps, to be called to the fact that the petitioners herein sought to secure a stay of the mandate until the case could be presented to this Court. The motion was refused.

"Proceedings," etc., at end of Transcript, pp. 24–26.

THIRD. If, in view of the sending down of the mandate, the writ of *certiorari* ought to issue to the Circuit Court, instead of to the Circuit Court of Appeals—a matter of practice believed to be solely under control of this Court—then we need only ask further that the Court shape its remedies accordingly.

GEORGE H. CHRISTY,
For Petitioners.

BI

Supreme Court of the United States.

In Re Petition
of
George Westinghouse, Jr., and The Westinghouse Air Brake Company for a Writ of *Certiorari.*

BRIEF IN SUPPORT OF PETITION.

The Supreme Court would not now be troubled with a request for its intervention, were it not that the case, in the opinion of counsel, fully justifies, if it does not imperatively require it.

When Congress passed the Act of March 3d, 1891, establishing Circuit Courts of Appeals, and, in patent cases, made their decisions final, it was anticipated that sooner or later conflicting and irreconcilable decisions would or might be rendered. And obviously, as the effect of such conflicts, a patent valid in one Circuit might be invalid in another Circuit; and an act of infringement, if committed in one Circuit, would be enjoined as wrong, and if persisted in, would be punished as a contempt of Court; while in another Circuit the same act would be held to be perfectly lawful, proper and innocent.

It goes without saying that such a state of things, if it should arise, would be, if not intolerable, at least so objectionable that all lawful means should be resorted to, in order to cure or prevent, as the case may be.

And especially is this true, when dealing, as in this case, with patents for railway train appliances. As is well known to everybody, railway cars go everywhere. Probably there is no railway car in the country which is not liable to be used in every one of the nine Circuits into which the United States is for judicial purposes divided. And it will be safe to say that every freight car in the country—and the invention here in controversy relates chiefly to the equipment of freight cars—at some time or other during its life of service, has been, or will be, run or operated in more than one circuit.

Every freight car going from Boston to Chicago, or the reverse, will traverse five Circuits. If it goes on to California, it will then traverse *all* the Circuits, except the fourth and fifth.

If it makes the same journey via the seat of government and St. Louis, it will traverse every Circuit except the fifth. And via New Orleans, it will go through more or less of at least six and possibly seven Circuits.

Hence the very serious evil of conflicting decisions in patent cases which relates to freight cars, cannot be otherwise than obvious.

The present case involves exactly that kind of a case or question.

But it may be admitted that a *mere* conflict is not enough. If for example, the invention in question be *trivial* and of *small importance* either as regards public or private interests, the necessity for review and revision by this Court would be less urgent. Where, however, the contrary appears, and especially where the question is one confessedly involving merit of the *highest* order, and public as well as private interests of *inestimable* value, then it is believed that a case is presented which, when the decisions thereon are at variance with each other, or with the well-settled law of the land, should be brought up for review.

The present case is one of that kind—the patent being a "pioneer" patent of high merit, great utility and of inestimable value in promoting the public interest.

The primary, ground-floor patents by which Mr. Westinghouse sought to cover and protect his invention of the "quick-action" brake, are two in number—known as Nos. 360,070 and 376,837. And, as is always the case with inventions of great merit and great commercial value, both patents were extensively infringed.

The first case to be reached on final hearing was, *inter alia*, for infringement of the second patent, No. 376,837. The two patents were so closely allied that, in order to construe No. 376,837, the Court was compelled first to construe the prior or first patent, No. 360,070. This was done by Judge TOWNSEND in the Circuit Court, and his reasoning and conclusions therein were adopted and affirmed by the Circuit Court of Appeals in the Second Circuit. Both patents were broadly construed in both courts.

> *Westinghouse vs. New York Air Brake Co.*, 59 Fed. Rep., 581.
>
> *Westinghouse Air Brake Co. vs. New York Air Brake Co.*, 11 C. C. A., 528; 26 U. S. App., ; 63 Fed. Rep., 962.

With the proper exhibits before the Court, and by a comparison therewith of the plain import of the decision of the Court of Appeals, the fact that *both* patents were construed, could be made to appear; but this is not necessary. In a later suit between the same parties, based on a new infringement, in which both patents were included, and on a motion for a preliminary injunction, Judge LACOMBE, who was a member of the Court of Appeals when the previous case was heard and decided, summed up with great brevity and force the views of that Court as embodied in the two opinions above cited. To quote his exact language (65 F. R., 99, 100), Judge LACOMBE says:

> "In those opinions it is held that the two Patents 360,070 "and 376,837 disclosed, the one the emergency valve, the "other the supplemental piston or special motor, which, so "far as the art has now progressed, appear to be both essen- "tial to the structure of a successful quick-action air brake. "Both of these inventions achieved great necessities and over-

"came great hindrances; each is an indispensable part of "the 'bridge which carried railroad-car builders from failure "'to success;' both were products of the inventive genius "of the same man; nothing anticipating either is shown."

*   *   *   *   *   *   *

"Although No. 360,070 was not declared upon in the "earlier suit, it was discussed at great length, and its meri-"toriousness was clearly recognized. The statements of the "problem to be solved as it stood prior to January, 1888, and "of the contribution of 360,070 to that solution, as they are "set forth in the opinions above cited, leave no doubt that "both the Circuit Court and the Court of Appeals regarded "it as a patent of wide breadth; the only difficulty being to "find sufficient standing room within the field it occupied to "permit of according to 376,837 also the necessary breadth "of construction to cover the infringing devices then before "the Court, and thus save to a meritorious inventor the fruits "of his novel and most useful invention."

That such was undoubtedly the force given to the prior Patent 360,070 by the Court of Appeals for the Second Circuit will further appear from the views which, in their first decision, they expressed of the second patent, 376,837. Of it they say (63 Fed. Rep., 962, 969):

"The defendants' theory mistakes the character and scope "of the invention, which was another and successful way to "accomplish the work designed to be accomplished by No. "360,070, and to be effected upon the same general plan of "instantaneous brake-pipe venting by the new means con-"tained in the supplemental chamber which have been "named. In No. 360,070 the stem of the triple-valve piston "directly engaged with the stem of the emergency valve "and consequently its action directly depended upon the "movement of the piston. The invention in 376,837 radically "departed from this method of actuating the emergency de-"vices by making a new piston independent of and uncon-"nected with the triple-valve piston. It was to be actuated "by auxiliary reservoir pressure, but the particular means by "which this pressure was to be permitted to exert itself,

" whether continuously or only when a port should be opened, " do not constitute an essential part of the invention. Means " must necessarily be shown in the specifications but " the identical means or the special devices were not, in " the language of Machine Co. vs. Lancaster, 129 U. S. 263, " 9 Sup. Ct., 299, 'necessary constituents' of the invention, " either in the specification or in the claim. The skill and " mechanical ingenuity of constructors of locomotives can, as " will be seen hereafter, in the examination of other patents " and of the infringing devices, arrange different details of " mechanical construction, by means of pistons, valves, ports " and springs, which, adopting the supplemental chamber " system first conceived and embodied by the patentee, and " a kindred, but not precisely the same, mechanical method " for the movement of the piston, will accomplish the same " result. The patentee was a pioneer, in that he de- " signed, in No. 376,837, a new way to accomplish a de- " sired result, but upon the same general idea which " he had unsuccessfully tried to work out in the earlier " patent. His later patent was the bridge, and not a " mere step, which carried railroad-car builders from failure " to success. It is not important now to determine the grade " of its pioneership, and whether it may be classed in the list " of those inventions which are of the highest rank; but it " was an invention created to achieve great necessities and " overcome great hindrances, and was one of wide breadth. " A court would not be justified in adopting 'a narrow or " 'astute construction' which should minimize the character " of the invention, leave its real scope open to trespassers, " and thus 'be fatal to the grant.' The claims of the patent " do not contract the grant to narrower limits than those " which the invention as made by the patentee actually cov- " ered, and the claims, therefore, are not limited to the pre- " cise mechanical means described in the specification, by " which the supplementary piston is actuated. They compel " it to be disconnected with and to be independent of a " triple-valve piston, and to be actuated by pressure from an " auxiliary reservoir by some means equivalent to the means " which are described in the specification. The rule which " permits, and indeed compels, courts to give a wide range to " the equivalents which a broad or pioneer patent can include

"is thus expressed in Miller vs. Manufacturing Co., 151 U. "S., 186; 14 Sup. Ct., 310: 'If the invention is broad or "'primary in its character, the range of equivalents will be "'correspondingly broad under the liberal construction which "'the courts give to such inventions.'"

When the present case was on hearing at Circuit, his Honor Judge MORRIS found the invention of this Patent 360,070 "paradoxical and startling." Thus he says (66 Fed. Rep., 1000, 1001):

"Now, although quick-action emergency brakes were being sought for, no one before Westinghouse had accom"plished this result, and the means by which he accomplished "it were entirely novel. Indeed, upon first impression, it is "paradoxical and startling to find that, when a sudden, "quick and powerful application of brakes is needed in the "face of impending danger, it is to be obtained by a sudden "large release of the pressure in the train pipe, to the extent "of 15 or 20 pounds below that in the auxiliary reservoir, "and that by using this low-pressure air to operate the brake "cylinder, instead of the air under greater pressure stored in "the auxiliary reservoir, this remarkably effective application "of the brakes is obtained. In the domain of quick-action "brakes this device would seem to belong to that class of pio"neer inventions the patents for which are to be construed so "as to be coextensive with the real invention, if the language "of the claim will permit it."

And the Court of Appeals for the Fourth Circuit make the same admission in the present case (Opinion, p. 19):

"That this invention of Westinghouse, thus undefined "[the Court then referring to claim 2], is one of the highest "value to the public, and that it is a pioneer one in the art "of quick-action air brakes is not denied, and is conceded. "It is conspicuously one of those pioneer inventions which "entitle the proprietor to a liberal protection from the "Courts in construing the claim."

These adjudications by two Circuit Courts and two Circuit Courts of Appeal, would seem to establish sufficiently our proposition

that the invention which is now brought to the attention of the Court, is one of no ordinary magnitude and importance. None of greater merit and value, except perhaps the Bell telephone and the incandescent electric lamp, has reached this Court during the present generation; and among those inventions which are for securing the safety of life and property, the Reports disclose none which even approach it in its bearing on public interests.

The First Assignment of Variance and Error.

Claim 2 of Patent 360,070 is the claim which, as is believed, in some respects, best expresses, sums up and covers one of the essential mechanical features and combinations of operative mechanism, which constitute the "pioneer" or basic invention here in question.

The Circuit Court of Appeals for the Fourth Circuit, in the opinion rendered by his Honor Judge HUGHES, says that this claim 2 is invalid, or, to use the exact language employed, that it is "fatally defective."

And this is so held by that Court, not because it is old, nor on account of anything shown in the prior art, but because, by reason of the fact that, omitting, as it did, to specify the particular means or mechanism by or through which the second or "further traverse" of the triple valve piston, opened the emergency valve and admitted air from the train pipe to the brake cylinder, it was to be held invalid, or as stated, because it claimed "only a result." In other words, the claim was held invalid as a matter of law arising on the face of the claim.

The ruling of that Court on that question is thus formulated (Opinion, p. 19):

> "We think that when claim 2 of 360,070 in its language "describing the action of that device, failed to describe any "means by which the extreme traverse of the piston pro- "duced it, declaring merely that the piston, 'by a further

"traverse, admits air directly from the main air pipe to the brake
"cylinder,' it was fatally defective, claiming only a result
"which is public property, and not identifying the specific
"means (his own property) by which the result is achieved."

This ruling is directly is conflict with a holding of the Circuit Court of Appeals for the *Second Circuit*.

It was there held that this claim 2 of Patent 360,-070 was valid, and the action of the Court below in awarding an injunction under this claim was affirmed. And this injunction is still in force in the Second Circuit.

The case at Circuit in which the injunction was granted has already been quoted from (*Westinghouse vs. New York Air Brake Co.*, 65 Fed. Rep., 99). Infringement was alleged *inter alia* of 360,-070 and 376,837. Judge LACOMBE granted a preliminary injunction under claims 1, 2 and 4 of 360,070, and claim 1 of 376,837. And it goes without saying that the allowance of an injunction, necessarily presupposes the validity of the claim under which the injunction was granted.

Defendants appealed, and the appeal was heard by Circuit Judges WALLACE and SHIPMAN and District Judge TOWNSEND. A "*Per Curiam*" opinion was filed (69 Fed. Rep., 715), affirming the decree of the Court below as to claims 1, 2 and 4 of Patent No. 360,070, and reversing only as to claim 1 of the other Patent No. 376,837.

This makes a clear case of conflict of decision between the Circuit Courts of Appeals of the Second and Fourth Circuits in the matter of an invention of highest value and importance—that is, the invention of claim 2—not only to the owners of the patent, but equally, or perhaps more so, to the public at large. And hence, it is believed to be a case calling for the intervention of this Court for purposes of review and revision.

And the urgency of the case becomes the stronger in view of the fact stated in the "thirteenth" paragraph (p. 5) of the petition herein,

that there are other causes involving this claim—unheard and undecided—and more particularly one in the Eastern District of Missouri.

If further proof were needed of the high value and importance of this Westinghouse "Quick Action" invention, the extent and character of the litigation thereunder would fully establish it. With approximate correctness the rule may be mathematically stated that the merit and value of a patented invention are directly as the square of the infringements that have taken place under it. Extensive infringement, widespread and vigorously-contested litigation are sometimes the best proof of meritorious invention.

It would seem to be unnecessary to do more than call the attention of the Court to the serious effects which are likely to follow from such a conflict of decisions. A basic claim for a pioneer invention, usable only on railway trains, valid and to be enforced in one Circuit, and at the same time invalid and *not* to be enforced in another Circuit, would, from a commercial and business standpoint, be regarded as simply intolerable. Public interests, independently of private rights, demand that the law as to the rightful use and control of railway train appliances, shall be uniform in all the Circuits, so that a car, whether free of the patent or subject to the patent in any one Circuit, shall sustain exactly the same relationship to that patent in all other Circuits. And, in the present case, there seems to be no way by which this desirable end can be secured except through exercise by this Court of its statutory right of review and revision.

In order not to overlook anything of importance bearing on this question, note should be made of the possible suggestion that this particular ruling of the Court of Appeals in the Fourth Circuit was, in part, at least, the result of the view which that Court took of the prior Westinghouse Patent, No. 220,556. Judge HUGHES does not so state his conclusions, but if he did, the case would remain the same as before. *The New York Court had this same patent before it, No. 220,556.* The Court of Appeals in the Second Circuit did not apparently consider it of enough importance to require discussion,

but as it is specifically mentioned by its number in Judge TOWNSEND's opinion (59 F. R., 586), it was actually in the case and before the Court, and the adjudication in the Second Circuit must be regarded as having been made in view thereof.

Hence there is nothing in this suggestion which can lessen or wipe out the variance or conflict which exists as between the decisions of these two Courts. They are directly at variance not only as matter of law, but also on the same state of facts.

These considerations are believed to sustain fully our first assignment of variance and error.

Second Assignment of Error.

"SECOND. As matter of error herein, your petitioners submit that the said decision of the said Circuit Court of Appeals for the Fourth Circuit, that the said Claim 2 of Patent No. 360,070 is 'fatally defective' in matter of form, or in the substance thereof, is not well founded in fact or in law."

The said claim 2 as printed in the opinion (p. 15) of that Court, and employing the italics which the Court has adopted to indicate the main feature of novelty and infringement, runs as follows:

> " 2. In a brake mechanism, the combination of a main air " pipe, an auxiliary reservoir, a brake cylinder, and a triple " valve having a piston whose preliminary traverse admits air " from the auxiliary reservoir to the brake cylinder, *and " which by a further traverse admits air directly from the " main air pipe to the brake cylinder*, substantially as set " forth."

Your petitioners aver and submit that—no other part of the claim being objected to—the portion so in italics is not "fatally defective" either in fact or in law.

The "*means*" are clearly defined, and the claim is not "*unlimited*."

(1) The second word in italics, "*which*," by its reference to its antecedent "piston," defines the *first* "*means*."

(2) "*A further traverse*," motion or movement of that piston is the *second* "*means*."

(3) The *third* "*means*," *a suitable valve*, is as necessarily implied as if it were named. The "*furth r traverse*," which is the second "means," "*admits air directly from the main air pipe to the brake cylinder*."

There is only one "*means*" known in the entire range of the mechanic arts by which to admit air from one receptacle to another, and that means is *a valve*.

(4) The *fourth* "*means*" is "*the main air pipe*."

(5) The *fifth* "*means*" is "*the brake cylinder*."

The fact that the claim omits to specify, and is not, in fact, confined to, the specifically illustrated and described connecting mechanism by and through which the "further traverse" of the *piston* opens, the *valve* does not make it "fatally defective," nor enable an infringer, who varies those means, to escape the claim.

This has been so recently settled by a unanimous opinion of this Court that a single citation is sufficient.

In *Deering vs. Winona Harvester Works*, 155 U. S., 286, 302, this Court said (p. 302):

> "Defendants further insist that the twentieth claim of this "patent is invalid by reason of the fact that, if the board *d*[1] "be construed, as it evidently must, as a board pivoted to "the butt adjuster, the combination is incomplete and inoperative, because the means by which it is held and controlled "are not stated in the claim. * * * Admitting that "additional elements are necessary to render the device "operative, it does not necessarily follow that the omission "of these elements invalidates the claim, or that the precise "elements described in the patent as rendering it operative

"must be read into the claim. If Steward were, in fact, the "first to invent the pivotal extension to a butt adjuster, he is "entitled to a patent therefor, though the infringer may "make use of other means than those employed by him to "operate it (*Loom Co. vs. Higgins*, 105 U. S., 580, 584).

"In such case any appropriate means for making it "operative will be understood. Otherwise, the infringer "might take the most important part of a new invention, and, "by changing the method of adapting it to the machine to "which it is an improvement, avoid the charge of infring- "ment."

For these specific reasons for assignments of errors of fact, your petitioners respectfully represent and submit that, in so far as relates to any matter of law, or any question of the form of the claim, it is not true that the said claim 2 claims "only a result."

And for the same reasons and to the same extent, your petitioners submit that the decision of the Circuit Court of Appeals in the Fourth Circuit, as to the invalidity of said claim 2 is manifest error, and that the decision of the Circuit Court of Appeals for the Second Circuit, that the said claim 2 is valid, is manifestly correct.

The discussion of this question and the conclusions reached in the opinion rendered by Judge SHIPMAN in the Court of Appeals, Second Circuit, quoted *supra*, are believed to be conclusive in their cogency.

Westinghouse Air Brake Co. vs. New York Air Brake Co., 63 Fed. Rep., 962, 969.

We are unable even to surmise a reply to our position herein, unless possibly it be this: That what Judge HUGHES *meant* to say, is that *if* claim 2 of 360,070 be so broadly construed as to cover or include the defendant's apparatus, then it must do so by covering or including the function common to the apparatus of both com-

plainants and defendants, and that a patent which covers a function is void.

If this surmise is correct—and we cannot think of any other—a sufficient answer thereto may be briefly stated :

(1) Whatever Judge HUGHES may have meant, *that* is not what he said. He pronounces claim 2 to be "fatally defective," and he does so without any conditions or limitations of any kind whatsoever. If he means what he says, and if what he says is not subject to correction in this Court, then it necessarily follows that claim 2 is absolutely void and of no force whatever, within the territorial limits of the Fourth Judicial Circuit. Nor can we *now* see how any Circuit Court in the Fourth Circuit could even listen to an argument to the contrary.

(2) The reason assigned by Judge HUGHES in support of his conclusion that said claim 2 is "fatally defective" is inconsistent with any suggestion that he really meant something else or something less. His language is brief, but clear and expressive beyond any apparent doubt or ambiguity. He says (Opinion, p. 19) :

" It [claim 2 of 360,070] was fatally defective, claiming only a " result which is public property, and not identifying the specific " means (his own property) by which the result is achieved."

Thus he seems to say as clearly as words can say it :

FIRST. That the claim is "*fatally defective.*"

SECOND. Because "*claiming only a result.*"

THIRD. He says that this result "*is public property.*"

[What Judge HUGHES meant by saying that this result "is public propeaty" is not clear, for in the next sentence he says that "this invention of Westinghouse * * * is a pioneer one," etc. If so, then the result was *not* "public property." But if he means that *all results* are "public property," then this phrase is to be read as the assignment by him of an additional reason for holding the claim to be void.]

Now, neither of these reasons have anything to do with the prior state of the art, nor with the issue of infringement, nor with the

proofs in the case. It is a bald holding that claim 2 is absolutely void for any purpose whatever, at least in the Fourth Circuit.

And we ask that this holding be reviewed, in this Court:

1st. Because it is directly in conflict with the decision of the Circuit Court of Appeals in the Second Circuit, where this claim was held valid, and where a defendant is now under injunction under it.

2d. Because it is erroneous in its reasonings as well as in its conclusion.

3d. Because such a holding must necessarily introduce serious confusion and conflict in the different Circuits in the administration and application of remedies thereunder; and

4th. Because it will, unless corrected, work irreparable injury to complainants, as to which latter more will be said presently.

Third Assignment of Error.

The present suit was originally brought in the Circuit Court on December 12th, 1889. *A little over two years later*, under date of August 16th, 1892, Mr. Boyden, one of the defendants, and president of defendant company, procured certain patents under the alleged protection of which the defense was thereafter conducted. Of these Boyden Patents, and of their relation to the case, Judge HUGHES says (Opinion, p. 17):

> "This question [of infringement] was presented necessarily to the Patent Office of the United States when Boyden applied for a patent for the device under consideration. That Office employs the best experts in mechanics which it can secure in this and other countries. Its examinations are indeed *ex parte* in form, but they are nevertheless conducted under hot and skilled contestation in every case of importance; and its decisions, though not conclusive, are entitled to great respect. That Office, after full examination, awarded a patent to Boyden on the 16th day of August, 1892, for his quick-action improvement on the device of Patent 220,556, and that action by the Office

" was, in effect, a ruling that the Boyden device did not in-
" fringe Westinghouse's quick-action Patent Number 360,-
" 070. That ruling takes rank here as the testimony of ex-
" perts of the highest experience, skill and knowledge in
" mechanics. That ruling was subsequent to the issuing to
" Westinghouse of both the patents, Numbers 360,070 and
" 376,837, four years after the latter patent, when the Patent
" Office had full knowledge of them."

The above ruling of the Court is excepted to, as well generally as specifically for the following reasons :

(1) It is not true as matter of fact or matter of law, that the Patent Office " employs the best experts in mechanics which it can secure in this and other countries."

Under a system of promotion regulated by the rules of our civil service system, ninety-six Examiners are employed at salaries ranging from $1,400 to $2,500 per annum.

Whether such low salaries under our civil service system can command the services of " the best experts," etc., is too doubtful to constitute properly a part of an adjudication as to valuable rights of property.

(2) The ruling that the examinations made in the Patent Office, though " *ex parte* in form," " are nevertheless," as stated in the extract above quoted, " *conducted under hot and skilled contestation in every case of importance*," is wholly an error. The only contests which can possibly take place in the Patent Office, under any Act of Congress now in force, are in interference cases—and Boyden and Westinghouse were never in interference. All other cases are *ex parte*, the proceedings therein are secret, and as to them no contest can possibly arise.

These errors, though perhaps comparatively small in themselves, lead up to two other errors, both of which are material.

(3) By the grant of a later patent to Boyden it is stated in the extract above quoted, " that action by the Office was in effect a

" ruling that the Boyden device *did not infringe* Westinghouse's " quick-action patent, number 360,070."

And at that time,—that is, at the time this Patent Office action was taken,—it will be remembered, this case and this question were pending in the Circuit Court.

The question of infringement, under the law, does not belong to the Patent Office, and until the present decision was rendered, it has never been so held.

The ruling or decision thus made, and stated with such freedom from ambiguity, coming as it does from a Court of last resort, is *alarmingly dangerous* to the interests of inventors and patentees everywhere, and is *most dangerous* to those inventions which possess the *highest merit.* What would this Court have said if it had been asked to decide in the Telephone Cases that by the grant of later patents to Dolbear, or to Drawbaugh, or to Edison, or to Gray, and granted while suits for infringement were pending, the Patent Office had made a ruling that the Dolbear, or the Drawbaugh, or the Edison, or the Gray telephone "*did not infringe*" the prior Bell Patent? We mean no disrespect to the Court whose decision we are now calling in question, by saying that, as we understand the law, such a holding is simply revolutionary. If such be the law, then the use of the Patent Office for the purpose of presenting, if not for manufacturing, testimony, to prove an issue upon which the prior patentee cannot be heard on his own behalf, hereby enjoys the highest judicial sanction which it can possibly receive outside of this Court, and in the hands of the infringer, becomes an implement of easy use by which to make in all cases a perfect defense. All he has to do is to apply for and procure at a cost of $35 a later patent for some further detail of improvement, real or pretended. He can *assert* in his application that his " improvement " or " modification " is not an infringement, etc. As the Patent Office has no jurisdiction of the question of infringement (except, of course, in interference cases, and then only for the purposes of the grant), such assertions in a specification are generally allowed to go unchallenged, and are left for the Courts to pass on. The *claim* is usually scrutinized—

nothing else is (100 U. S., 671, 2). Then, no matter how limited the claim, or how trivial the invention, the later patentee, *by merely getting a patent*, obtains, under the decision now in question, an *ex parte* ruling, not that his device involves merely some patentable additions to, or modifications of, the prior patent, but that it departs so essentially from the *claims* of the prior patent that it does not embody its essential features at all—or, in other words, that it *does not infringe*. By the mere grant of a patent so procured, he would have, under Judge HUGHES' decision, a ruling by the Patent Office of *non-infringement*, which he could properly use as a defense.

Such a defense, so made, has thus been held not merely to raise a *prima facie* presumption that the later patent involves some patentable differences from the prior patent, but that its grant, though not conclusive, is sufficient as a defense, and this ruling has been made by a Court of last resort; and if the error be not corrected, it will work irreparable injury, alarming both in amount and extent, to the most meritorious inventors of our nation—or of the world.

The facts on which this singular decision was made are correctly stated by Judge MORRIS in his decision, and his ruling thereon may properly be quoted here as being substantially correct in its application of the law to those facts. Judge MORRIS (66 F. R., 1006, 1007) says:

> " It is further urged that in a doubtful case the scale " should be turned by the fact that, subsequent to the date " of the patent in suit, indeed more than two years after the " institution of this suit, Patents Nos. 481,134 and 481,135, " August 16, 1892, were granted to Boyden for the mechan- " ism now used by the defendant.
>
> " Boyden was entitled to patents for whatever was a " patentable novelty in the devices by which he was able to " make his valve 22 answer for both service and quick-action " work in connection with the restricted passage B, and for " any other patentable novelty in the forms of his mechan- " ism. The widely different forms in which he has illustrated

" his devices in the two above-mentioned patents show that, " taking what Westinghouse had discovered and demonstrated " to be the underlying principle of a quick-action brake, a " skillful and inventive mechanic can devise many forms for " applying it.

" But, in his specification of Patent No. 481,135, Boyden " alleges that his device differs essentially from Westing- " house's Patent No. 360,070, and involves a new mode of " operation. The question whether it does or does not was " the very question then pending in this suit, and, so far as the " Examiner passed upon it, in allowing the specification to " stand, he did so upon the *ex parte* application of Boyden " and unassisted by testimony as to the state of the art at the " date of the Westinghouse Patent, and without testimony as " to the scope of the Westinghouse quick-action invention " and its great importance and merit; and, therefore, with- " out the opportunity of judging whether or not it was a " pioneer invention of a fundamental character, entitled to a " construction co-extensive with the invention, or was simply " a patent for an improvement in a known art, to be restricted " to the form of the device shown in the model and illustra- " tions.

" The determination of that question is the starting point " in the consideration of the controversy, and, in my judg- " ment, the fact that Westinghouse was the first discoverer " of the vital underlying invention, should turn the scale in " his favor."

Contrasting with this the ruling made by the appellate tribunal, it is respectfully but urgently submitted that an error so gross, and in its probable results so fraught with danger to the most meritorious inventors known to the law, should not be allowed to pass without correction; and this is the only Court where it can be authoritatively corrected.

Not only is it true that the Patent Office has no authority to decide or even pass on a question of infringement for the Courts, but it is equally true the Patent Office is not authorized to make or create testimony for the Courts.

While the decision herein complained of does not go to the extent of holding that a Patent Office ruling is *binding* on the courts, and, in fact, says that it is not conclusive, it does give to such ruling an effect which, to say the least, has no foundation in law, and also is highly pernicious. In the sentence next following the clause last quoted, Judge HUGHES says of this Patent Office ruling that it

> "takes rank here as the testimony of experts of the highest experience, skill and knowledge in mechanics."

It would seem to be almost needless to suggest that if a subsequent improver on a pioneer invention can, by the mere *ex parte* act of procuring a subsequent patent, after being sued, *make or create* "*testimony*" *for himself*—and testimony which may "take rank" in a Federal Court as that "*of experts of the highest experience, skill and knowledge in mechanics*," then one of the great safeguards erected for the protection of patented property is entirely destroyed. *On mechanical questions the law knows no higher testimony than that which is thus defined; and hence, when such testimony is furnished, it cannot successfully be rebutted.*

And if this be a correct statement of the law, then, in patent cases, under the issue of infringement, the Courts will have little to do (except in cases of *manifest* error) but to register and enforce the *ex parte* rulings of the Patent Office.

Miller vs. Eagle Manufacturing Co., 151 U. S., 186, stated the rule that the grant of the later patent merely raised "a *prima facie* presumption" of the existence of a "patentable difference" in the latter patent (p. 208), but in other branches of the case this Court distinctly declined to follow and apply a ruling of the Patent Office as to the existence of patentable difference between two patents issued by the Patent Office (p. 202). The

BLEED THROUGH POOR COPY

decision of the Circuit Court of Appeals of the Fourth Circuit goes far beyond any decision of this Court in attributing weight and value to the *ex parte* rulings of the Patent Office.

The decisions heretofore made by this Court are believed to be in strict accord with the views we are seeking to present.

The question arose in *Blanchard vs. Putnam*, 8 Wall., 420. Mr. Justice CLIFFORD, in rendering the opinion of the Court (p. 426), said:

> "Attempts are often made in the trial of patent cases to "introduce such collateral issues on the questlon of infringe-"ment, but they are irregular and cannot be sanctioned, as "the only proper comparison, on that issue, is of the defend-"ant's machine with that of the plaintiff, as prescribed in the "pleadings. What the jury have to determine is, does the "machine of the defendant infringe the machine of the "plaintiff; and if it does not, then the defendant is entitled "to a verdict; but if it does infringe the plaintiff's machine, "then the plaintiff is entitled to his remedy, and it is no "answer to the cause of action to plead or prove that the "defendant is the licensee of the owner of another patent, "and that his machine is constructed in accordance with that "patent.
>
> "Controversies between litigants in court cannot be com-"pleted in that way, nor should the plaintiff be subjected to "such outside issues, as he is clearly entitled to a verdict "when he has proved that he is the original and first inventor "of his improvement, and that the defendant has infringed "his patent."

The present case comes exactly within the rule thus stated in these essential features:

(1) A pioneer patent to complainant.

(2) A structure or device made by defendant.

(3) An issue of infringement raised thereby.

(4) A later patent under which defendant claims to be working.

(5) A case for final disposition, not for a preliminary injunction

Under these facts and conditions, *Blanchard vs. Putnam* says

that the patent under which defendant claims to be working is not admissible in evidence at all *under the issue of infringement.*

Later cases which *look like* modifications of this rule relate, for the most part, if not entirely, either to some side or collateral issue, or else are exceptional in their nature.

In *Boyd vs. Tool Co.*, 158 U. S., 260, neither party was a pioneer, and both applications were pending at the same time—a very different case.

In *Pavement Co. vs. City of Elizabeth*, 4 Fish., 189, cited in *Boyd vs. Tool Co.*, the question arose *on a motion for a preliminary injunction.* In such proceedings presumptions count as evidence, and hence a patent to defendant is worth something in support of a presumption.

But on final hearing, or in what is practically the final disposition of a case, mere presumptions do not count for much. And even in *Miller vs. Eagle Co.* it was merely referred to as a confirmatory consideration, and then only as of a *prima facie* character.

In *Wollensack vs. Reiher*, 115 U. S., 96, the effect to be given to a Patent Office decision arose under a question of reissue. More than two years had elapsed between the date of the original patent and the date of the reissue. Proofs satisfactory to the Commissioner of Patents had been submitted to the Patent Office, so as to account for the delay, and the Commissioner, being satisfied with those proofs, had granted the reissue. These facts were set up in the bill. Defendant demurred, and the Supreme Court, in sustaining the demurrer, after reciting the facts as above stated—that is, the decisions which had been made on the proofs so submitted—added the following (p. 101):

> "But this does not satisfy the law. The question as to whether the delay had been reasonable or unreasonable is for the courts to determine, upon the special circumstances brought to its attention, and it cannot substitute the decision of the Patent Office upon that question for its own."

Hence, it is believed that the law of *Blanchard vs. Putnam* is still the law of the land. And even if later decisions have

tended to modify it, it has never been modified as applicable in a suit on a pioneer patent, and still further has never been so far modified that a grant of a patent becomes testimony of high rank as establishing non-infringement in a Federal Court, and still more so when the later patent is not procured until more than two years after suit is brought.

It is submitted that the effort to raise *ex parte* departmental decisions practically to the rank of adjudications which are authoritative as "testimony" in Federal Courts of last resort, embodies so great and dangerous an error as to create an unusually urgent call for the intervention of this Court by the exercise of its statutory powers of review.

Fourth Assignment of Variance and Error.

This relates to the force and meaning of the phrase "substantially as set forth," which is appended to claim 2 of 360,070. The ruling therein of the Circuit Court of Appeals for the Fourth Circuit is believed to be directly at variance with the decisions of this Court, and to be in error as matter of law.

The ruling thus assigned for variance and error is formulated or stated by Judge HUGHES as follows (Opinion, pp. 15, 16) :

> "The phrase 'substantially as set forth' is technical, and "is equivalent to saying 'by the means described in the text "'of the inventor's application for letters patent, as illustrated "'by the drawings, diagrams and models which accompany "'the application.' These words limit the general terms "of the specification which set out the *function* performed "by the invention, and confine the inventor's rights to his "own *means*, or their mechanical equivalent of performing "the function."

It is submitted that in this extract are contained two statements of law, both of which are at variance with the rulings and decisions of this Court.

1. In holding that "substantially as described" is a limiting phrase, not as to the *general combination* of mechanism recited in the claim, but as to elements of mechanism *not* recited in the claim, and which may be varied from without departing from the main invention.

In Lake Shore & M. S. Co. vs. National Car Brake Shoe Co., 110 U. S., 229, 235, this identical question arose, and, under one of the claims in suit, was the main point in controversy. The question is discussed at length (p. 235). We quote three lines, the italics being our own :

> " The words 'substantially as specified' mean substan-
> " tially as specified in regard to *the combination which is the*
> " *subject of the claim.*"

In *Deering vs. Winona Harvester Works*, 155 U. S., 286, 302, the twentieth claim of the patent in suit was in the following words (p. 290) :

> " 20. The combination in a grain binder, of moving butt-
> " adjusting mechanism, and the board d^1, *substantially as*
> " *described.*"

The defendants insisted (p. 302) that this 20th claim was invalid because the *means* by which the board d^1 was held and controlled in its pivotal connection to the butt-adjuster were "not stated in the claim," or that certain additional elements by which it was described as so held and controlled, must be "read into" the claim, but this Court (as already quoted) decided otherwise, saying (p. 302) :

> " Admitting that additional elements are necessary to ren-
> " der the device operative, it does not necessarily follow
> " that the omission of these elements invalidates the claim,
> " or that the precise elements described in the patent as ren-
> " dering it operative must be read into the claim. If Steward
> " were in fact the first to invent the pivotal extension to a
> " butt-adjuster, he is entitled to a patent therefor, though the
> " infringer may make use of other means than those em-
> " ployed by him to operate it (*Loom Co. vs. Higgins*, 105 U.

> " S., 580, 584). In such case any appropriate means for
> " making it operative would be understood. Otherwise, the
> " infringer might take the most important part of a new in-
> " vention, and, by changing the method of adapting it to the
> " machine to which it is an improvement, avoid the charge
> " of infringement. The invention of a needle with the eye
> " near the point is the basis of all the sewing machines used ;
> " but the methods of operating such a needle are many, and
> " if Howe had been obliged to make his own method a part
> " of every claim in which his needle was an element, his pat-
> " ent would have been practically worthless."

The decision of Judge HUGHES is directly at variance with this in that it applies this phrase "substantially as described," to the *particular* "*means*" which are merely *supplementary* to the elements of the claim (meaning a particular valve and particular passage way to it, illustrated by Westinghouse), instead of, as it should do, to *the combination* of those elements which are actually recited in the claim.

The same rule of construction is practically embodied in the following extract from the old (1853) case of *Winans vs. Denmead*, 15 How., 330, 342:

> " It is generally true, when a patentee describes a ma-
> " chine, and then claims it as described, that he is under-
> " stood to intend to claim, and does by law actually cover, not
> " only the precise forms he had described, but all other
> " forms which embody his invention ; it being a familiar rule
> " that, to copy the principle or mode of operation described
> " is an infringement, although such copy should be totally
> " unlike the original in form or proportions."

Such has always been the uniform rule in the Federal Courts, especially when dealing with "pioneer" inventions. It is hardly conceivable that the door is now open for the establishment of a different and less favorable rule.

(2) The other variance, or rather error, double in its character, arose from the failure on the part of the Court of Appeals in the

Fourth Circuit to note two important limitations in applying the rule as to "means" and "mechanical equivalents."

(a) As to "means," the inquiry was not limited, as it should have been, to the means which are *essential and substantial to the invention.* This was clearly an error.

(b) As to "mechanical equivalents," the liberal rules of construction repeatedly announced from this Bench as applicable to pioneer inventions, were either overlooked or ignored. Such rulings are too numerous for quotation, but reference may be made to the following leading cases :

Morley Machine Co. vs. Lancaster, 129 U. S., 263, 273.
Clough vs. Barker, 106 U. S., 166, 177.
Consolidated Valve Co. vs. Crosby Valve Co., 113 U. S., 157.
McCormick vs. Talcott, 20 How., 402, 405.
Deering vs. Winona Co., 155 U. S., 206, 302.
Miller vs. Eagle Mfg. Co., 151 U. S., 186, 207.

And for a convenient summing up of the law herein, and for a proper application of such law to a collateral branch of this case, we respectfully refer the Court to the extract, *supra*, pp. 4–6, from the decision in the Court of Appeals in the *Second* Circuit (63 F. R., 969). What is there said under Patent 376,837, is *mutatis mutandis*, applicable in still higher degree under the earlier Patent 360,070.

The correction of these errors is material to the rights of the petitioners herein.

This will amply appear on a brief statement of a few facts.

(1) The Westinghouse Patent No. 360,070, here in suit, is a pioneer patent, or the first of its kind, and is so both confessedly and by all the adjudications yet made thereunder.

(2) Claim 2 of this patent, held valid in one Circuit and invalid in another Circuit, is a claim which is most broad and comprehensive in its terms, and, if valid, will give efficient and ample protection to the actual invention stated therein. If held to be

invalid, so much of the invention as is within its scope, and outside the scope of the remaining claims, will cease to have any protection whatever.

Believing the decision in the Fourth Circuit as to the invalidity of this claim to be in error, and as well at variance with the decision in the Second Circuit, and believing that thereby a valuable and material portion of the Westinghouse "Quick Action" invention is liable to fail in receiving proper and lawful protection, it is submitted, not only that the variance and error are material, but that they are *so* material as to be entitled to corrective relief in this Court.

(3) The adverse rulings made in the opinion of Judge HUGHES as to the effect of the issue of later patents to Boyden, and as to Patent Office rulings generally, bearing directly *on the issue of infringement*, and being so stated by the Court, cannot be otherwise than highly material to the rights of the petitioners herein.

(4) And the same is true as to the limitations imposed on said claim 2, under the phrase "substantially as set forth." But for these limitations the issue of the infringement must have been found in favor of complainants below—the petitioners here. And this will appear from a comparison of defendant's device with the terms of the claim, as well as from Judge MORRIS' opinion rendered in the Court below (66 F. R., 997).

Hence it is submitted that the correction of *these* errors, and without regard to other material errors yet to be noted, will probably, if not necessarily, result in a finding in this Court in favor of the petitioners herein, and a reversal on all the claims of the decision now sought to be reviewed.

Irreparable Injury.

Proper averment of "irreparable injury" to petitioners is made in the "fifteenth" paragraph of statement in the petition for the writ (Petition, pp. 5, 6).

It would seem to go without saying that a case of "irreparable injury" of most serious character was presented, when a Court of last resort (erroneously as is alleged) holds to the invalidity of the claim which, in its terms, appears to afford the best protection to the invention as made, and especially when such holding is in direct conflict with a decision of the same question in another Court, also of last resort, in another circuit.

Still more so when such erroneous decision limits the claim unduly, by reliance on *ex parte* "testimony," created for the purpose, by the procurement of a patent by defendant after the suit was brought.

And still more so, when the decisions of this Court are overlooked or disregarded in imposing, under "substantially as set forth," improper and unauthorized limitations on the claim.

And these considerations acquire still greater cogency in view of the fact that over four hundred thousand cars, passenger and freight, have been equipped in this country with quick action brake apparatus under (as was supposed) the protection, inter alia, of this claim 2 of Patent 360,070. Fully an equal or perhaps a still greater number yet remains to be equipped. And under Act of Congress, such further equipment must be completed by or before January 1st, 1898.

These suggestions apply more or less perfectly under remaining assignments of error, but we insert them here merely as a matter of convenience.

Fifth Assignment of Error.

FIFTH. As further matter of error herein, and as a matter irreconcilably at variance with the ruling of the Circuit Court of Appeals in the First Circuit, your petitioners further submit that manifest error was made by the said Circuit Court of

Appeals for the Fourth Circuit, in holding as matter of law that the mere erasure from the specification as originally filed, of a description of a proposed modification, operates as a disclaimer of such modification.

In the Westinghouse specification as originally filed, a *non-integral* emergency valve was described, and a clause was added to the effect that " the same office is performed by a valve *integral* with the main valve," etc.

The Patent Office, under its rules of practice, required this clause to be erased, for the reason that such an *integral* structure was not illustrated in the drawings. Whether, as a mechanical equivalent, it would come within the terms of the claims as allowed, was a question with which the Patent Office had no concern. The decision of that question belonged to the Courts. The clause in question was erased. Judge HUGHES' opinion, as understood, holds that an *erasure* in law amounts to a *disclaimer*.

This question arose directly in the Court of Appeals, in the Second Circuit, and it was held otherwise.

> *Reece Button-Hole Machine Co. vs. Globe Button-Hole Machine Co.*, 21 U. S. App., 244 ; 10 C. C. A., 194 ; 61 Fed. Rep., 958.

This Reece case contains probably the fullest discussion this question has ever received. Supreme Court cases are cited in large number and applied or distinguished. The conclusions reached by the Court in the Reece case, seem to be well founded in law, but the discussion is too lengthy for quotation in full. In 61 Fed. Rep., 967-970, will be found the portion of that decision here in point. The reasons there presented are so persuasive that we feel safe in submitting this part of our case thereon.

The remaining assignments of error do not probably contain any matters more imperatively requiring review and correction than those above presented.

Hence we deem it unnecessary to weary the Court with a discussion of them in detail; and the more so, because of the complicated character of the apparatus in which the invention is embodied, and because of the contradictory character of the testimony. In fact there are, we believe, only two important facts in the case, as to which there is no dispute.

FIRST. The merits and high rank of the Westinghouse invention as a pioneer in this branch of the arts, are not denied.

SECOND. There is no dispute as to the form or construction of defendant's apparatus.

Everything else is denied. The method of operation involved in the orderly movemement of the piston and valves of defendant's apparatus, and the relationship of that apparatus to complainant's patent, and to sundry prior patents, are among the chief questions in dispute. And these questions involve sundry matters of fact which cannot be made clear except by oral presentation, or in lieu thereof, by a written treatise on air brakes of such length and fullness that no court can reasonably be asked to read it.

For these reasons, our right to a writ of *certiorari* herein is' submitted on the first five assignments of error. When the cases come up for oral argument, if the Court should so order, we will ask to be heard, if need be, on the matters referred to in the other assignments of error.

FREDERIC H. BETTS,
GEORGE H. CHRISTY,
For Petitioners.

GEORGE H. CHRISTY,
Solicitor.

FREDERIC H. BETTS,
J. SNOWDEN BELL,
BERNARD CARTER & SONS,
Of Counsel.

BLEED. THROUGH POOR COPY